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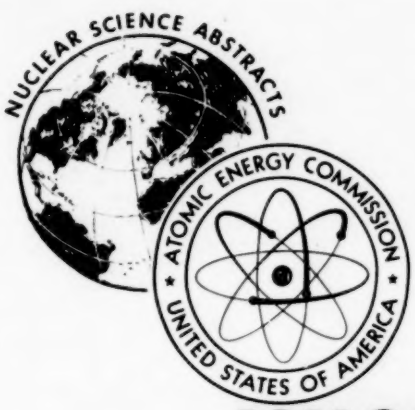

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Volume 18, Number 4, February 29, 1964

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

4938 (AD-298530) RADIOBIOLOGY. Information Series, Number 1, Volume 2. (Armed Services Technical Information Agency, Arlington, Va.). Apr. 1963. 255p.

Titles and abstracts are presented of 910 reports on radiobiology published between 1958 and 1962. An index by major subjects is included. Recently initiated research projects that are not covered in the bibliographical section are listed in the appendix. A proposed radiobiology vocabulary and code sheets for use in the preparation of a descriptor index are included and their use in a rapid reference service is described. (C.H.)

4939 (NP-13281) QUARTERLY PROGRESS REPORT NO. 49 [ON RADIOBIOLOGY]. (Chicago. Univ. Air Force Radiation Lab.). Oct. 15, 1963. Contract AF41(609)-1693. 125p. (AD-422960)

Separate abstracts were prepared on 9 sections of this report. (C.H.)

For abstracts of individual sections see: 5000, 5001, 5002, 5003, 5134, 5135, 5136, 5137, and 5138.

4940 (ORNL-TM-712) LEAK AND STRENGTH TESTS OF OLD COBALT-60 TELETHERAPY SOURCE CAPSULES SEALED WITH LEAD O-RINGS. K. W. Haff (Oak Ridge National Lab., Tenn.). Dec. 23, 1963. Contract [W-7405-eng-26]. 10p.

The results of tests on 18 5- to 8-yr old Co^{60} teletherapy sources indicate that the sources will withstand considerable physical shock. However, since they all leaked, their lead O-ring gaskets were in poor condition, and transferable contamination was high, it was recommended that sources of this type be reencapsulated in an all-welded stainless steel can before being reused. (auth)

4941 (SB-455(Rev.)) BIOASTRONAUTICS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). 1963. 31p.

References are presented to publications in the field of space biology. Topics covered include physiology, biology, behavior, food and nutrition, and protective clothing in space. (H.M.G.)

4942 (SB-519) SPACE MEDICINE. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). 1963. 20p.

A selective bibliography is presented that contains 244 references to reports and translations in the field of space medicine. References to 5 bibliographies on the literature from 1952 through 1957 are included. (C.H.)

4943 (SB-521) SPACE ENVIRONMENTAL CONDITIONS—BIOLOGICAL ASPECTS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). 1963. 16p.

One-hundred eighty-five references are presented to reports covering the biological aspects of space environmental conditions. References are included to bibliographies of U. S. and Soviet literature. (C.H.)

4944 (TID-4201) RESEARCH AND DEVELOPMENT IN PROGRESS—BIOLOGY AND MEDICINE, NOVEMBER 1963. Issue No. 2. (Division of Technical Information Extension, AEC). 323p.

Summaries are presented of biomedical research projects in progress in Nov. 1963 at AEC laboratories and major contractor sites. Indexes of subject, contractor, principal investigator, and contract number are included. (C.H.)

4945 (UCRL-11033) BIOLOGY AND MEDICINE SEMIANNUAL REPORT, SPRING 1963. John H. Lawrence, ed. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion). Contract W-7405-eng-48. 155p.

Separate abstracts were prepared on 16 sections of this report. A list is included of publications during the period covered. (C.H.)

For abstracts of individual papers see: 4946, 4963, 4964, 4965, 4966, 4967, 4968, 4969, 5004, 5005, 5006, 5007, 5008, 5009, 5184, and 5185.

4946 (UCRL-11033(p.19-28)) DEPTH DOSE IN LARGE PHANTOMS IRRADIATED OMNIDIRECTIONALLY WITH HIGH-ENERGY PROTONS. Charles A. Sondhaus, Palmer G. Steward, and Roger W. Wallace (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A series of calculations were programmed for the 7090 computer to predict approximately the dose, particle energy, and LET distribution in an omnidirectionally irradiated spherical lucite phantom as a function of incident high-energy protons and of sphere diameter. The calculations will be used in investigations of the biological effects of solar-flare proton flux during the course of space flight. (C.H.)

4947 (AEC-tr-6189) A UNIVERSAL RADIATION DOSE UNIT. V. I. Ivanov. Translated from [IAEA] Paper No. SM-44/60 Presented at the Conference on Biological Effects of Neutron Irradiations, Brookhaven National Laboratory, October 7-11, 1963. 10p.

A universal radiation dose factor (REB) is proposed that has the same value for any type of radiation regardless of its spectrum. The distinguishing feature of this new radiation dose characteristic is that it depends only on the physical parameters that determine the interaction of radiation with matter. Results are presented of calculations of dose for neutron and γ radiation using the formula. The average proton energy was considered equal to half of the neutron energy for the purpose of dose calculation. (C.H.)

4948 VARIATION IN NEONATAL DEATH RATE AND BIRTH WEIGHT IN THE UNITED STATES AND POSSIBLE RELATIONS TO ENVIRONMENTAL RADIATION, GEOLOGY AND ALTITUDE. Douglas Grahn and Jack Kratchman (Argonne National Lab., Ill. and U. S. Atomic Energy Commission, Washington, D. C.). Am. J. Human Genet., 15: 329-52(Dec. 1963).

Variation in the neonatal death rate in selected areas of the Western United States was evaluated with reference to the geologic environment and the presence or absence of known U and He reserves. While the neonatal death rate is unquestionably higher in the mountain regions, this does not appear to be attributable to higher levels of terrestrial radiation. A significant positive relationship does exist between death rate and altitude. The increased death rate can be largely attributed to a lower birth weight, since the frequency of immature births, on a weight criterion, progressively increases with altitude. The observed correlations with altitude have been evaluated in terms of either the increase in cosmic radiation intensity or the decrease in O partial pressure, or both. The data have been evaluated in terms of three hypotheses; radioinduced mutation, radioinduced injury to the fetus, and hypoxia-induced depression of fetal growth. Very little of the excess neonatal death can be attributed to the readily defined genetic factors, and direct fetal irradiation was concluded to be of no significance. The weight of the historical, experimental, and clinical evidence strongly suggests that the reduced partial pressure of O is responsible for the reduced fetal growth and subsequently increased neonatal death rate. (auth)

4949 THE PHARMACEUTICAL AND MEDICAL SIGNIFICANCE OF HUMAN BODY RADIOACTIVITY MEASUREMENTS. John E. Christian (Purdue Univ., Lafayette, Ind.). Bull. Parenteral Drug Assoc., 17: 1-10 (Jan.-Feb. 1963).

The detection and analysis, especially of K^{40} and Cs^{137}, by human wholebody scintillation counting are discussed. Average levels of radioactivity, which result from the decay of the major radionuclides in man, are tabulated. The basic principles involved in liquid scintillation counting are outlined. The liquid scintillation counter (SINCO-P) is described and its advantages are listed. In comparison with crystal scintillation counters, the resolution of γ energies is not as discrete; however, activity of different nuclides can be satisfactorily resolved if their γ energies are sufficiently different. The counter consists of two 2-π detector tanks of welded construction fitted together to form a 20-in. dia. center well 72 in. long. At the sides of the two tanks are twelve 16-in. photomultiplier tubes. Each tank is filled with 90 gal of a liquid scintillation solution. The complete detector is housed inside a 92-in. deep, 88-in. wide, and 84-in. high steel room that provides a shield of 6 in. of mild steel in all directions. Applications of the counter are cited. K^{40} measurements of lean body weight of football players are compared with measurements on students not involved in unusual physical activity. On the average, the football players measured 12 to 14% higher lean body weight, indicating the potential of determining physical fitness states by K^{40} measurements. (BBB)

4950 CIRCULARITY OF THE GENETIC MAP OF BACTERIOPHAGE T4. Henriette M. Foss and Franklin W. Stahl (Univ. of Oregon, Eugene). Genetics, 48: 1659-72(Dec. 1963).

Support is indicated for the conclusion that the genetic map of T4 is circular. The circularity is demonstrated in two types of experiments, standard four-factor crosses and cross reactivation experiments using γ-irradiated phage with four genetic markers. The circular pattern of marker knockout in the cross reactivation experiments argues that the circular linkage map of T4 is implicit in the chromosomes of the mature, irradiated phage. These results, therefore lend some support to the idea that the linear genetic sequences of the individual chromosomes in a T4 population are circular permutations of each other. (auth)

4951 STUDIES ON FRACTURE HEALING IN VIVO BY USING RADIOACTIVE STRONTIUM. A. Guha, Guru Charan Prasad, and K. N. Udupa (Banaras Hindu Univ., India). Indian J. Med. Res., 51: 298-303(Mar. 1963).

Scintillography and autoradiography were used to study the healing of humeral fractures in rats injected with Sr^{85}. Among various agents studied for an influence on the rate of fracture healing, the total extract of the herb Cissus quadrangularis was tested. In both controls and animals receiving C. quadrangularis extract there was demineralization of the fractured bone at the site of fracture. In the treated group, there was a somewhat earlier rise in Sr^{85} uptake just after the first injection. Thereafter, uptake again became high, similar to the control samples from the 6th day onward. The maximum uptake of control bone was found to be around the 19th day after fracturing, while in the treated group, maximum uptake was on 15th day. Though there was a minor difference in the period of maximum uptake between treated and control bone, the rate of uptake in the treated sample was markedly higher than that of the control sample. The fall of Sr^{85} uptake in the treated bone was very rapid, whereas in the untreated animals it was more gradual. All these findings on the uptake of Sr^{85}, as measured by a G-M counter, corroborated x-ray pictures and gross autoradiography at different stages of fracture healing. The radiological and autoradiographic findings also clearly showed that the healing in the treated group was quicker than in the controls. Furthermore, the callus in the treated animals underwent remodeling processes much earlier than in the nontreated ones. It is concluded that if the uptake of Sr in the treated animals is greater than in the control samples at the site of fracture, healing activity is more pronounced. However, studies on patients have shown that the uptake of Sr^{85} alone in the fractured region may not give an accurate picture of the healing processes. Thus, at the end of first week after fractures, accretion rate of Ca reached a peak and thereafter remained higher than normal throughout the period of healing. But when these results were compared with x-ray pictures, it was observed that the accretion rate in poorly uniting fractures did not differ from that of normally healing fractures, so that in interpreting the rate of healing by the uptake of Sr^{85}, radiography is also required to make the correct assessment of the status of fracture healing. The Sr^{85} uptake curves show that the uptake pattern can be divided into three definite phases. In the first phase, which lasts for six days, there is an enormous amount of decalcification from the broken fragments of bone possibly due to increased vascularity of the region, and also to the increased accumu-

lation of mucopolysaccharides locally. In the second phase, which lasts for another 8 to 12 days, rapid increase in the accretion of Ca as evidenced by increase in the uptake of Sr^{85} is noted. During the 2nd phase, histologic studies indicated that large amounts of collagen fibers appear, which possibly combine with all the available Ca salts there. The third phase shows a rapid fall of Sr^{85} uptake, indicating that the callus formed in the second phase is rapidly being remodeled. (BBB)

4952 Zn^{65} CONTENT OF SALPS AND EUPHAUSIIDS. Charles Osterberg (Oregon State Univ., Corvallis). Limnol. Oceanog., 7: 478-9(Oct. 1962).

Comparisons were made of the Zn^{65} content in plankton collected during July, August, and November 1961 in the Pacific Ocean near the mouth of the Columbia River, 200 mi south, and 50 mi offshore. A gradual decrease with distance from the mouth of the Columbia River indicated that the river is the major source of this isotope. (C.H.)

4953 SKIN CONTAMINATION BY RADIOACTIVE ISOTOPES. I. PIG SKIN CONTAMINATION BY $^{90}Sr-^{90}Y$ AND ^{32}P. Yoshiki Wadachi, Shingo Tashiro, Yūzō Tajima, and Tetsuo Hiyama (Japan Atomic Energy Research Inst., Tokyo and Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 938-43(Nov. 1963). (In Japanese)

Fresh pig skin was contaminated with carrier free Sr $Sr^{90}-Y^{90}$ or P^{32} and after a certain time elapsed, it was sliced off about 0.5 mm in thickness. The adhered contamination of outer skin (the adhered contamination) or the permeated contamination of inner skin (the permeated contamination) in each sliced sample was measured by low background G-M counter. The results showed that in regard to $Sr^{90}-Y^{90}$ and P^{32}, the adhered contamination changed extraordinarily within 60 min after contamination and then increased gradually with an increase of contaminating time, particularly in the case of $Sr^{90}-Y^{90}$, pH of contaminating solution affected the adhered contamination. Furthermore, Y^{90} showed a selective adhesion at the broad pH region, that is, from a weak acidity to an alkalinity. On the other hand, the results showed that in regard to $Sr^{90}-Y^{90}$ and P^{32}, the permeated contamination increased with an increase of contaminating time and that P^{32} permeated quickly more into the inside of skin than that of $Sr^{90}-Y^{90}$. Y^{90} contributed greatly to the permeated contamination as well as to the adhered contamination, if pH of $Sr^{90}-Y^{90}$ solution was over 4.5. (auth)

4954 POSTSURGICAL AND POSTIRRADIATION FISTULAS TREATED BY COLPOCLEISIS. H. Monaco, V. Layana, and C. Lebrero. Prensa Med. Arg., 49: 2144-9(Oct. 12, 1962). (In Spanish)

Vesicovaginal and rectovaginal fistulas are a frequent occurrence following radiation treatment for cancer, as well as a sequel to some operative procedures. Five cases of genital fistula, one rectovaginal and four vesicovaginal, were treated by a modified Latzko technique of partial colpocleisis. Four fistulas were due in part to radiation and in part to surgery; one was the result of surgery alone. The modification of surgical technique for repair of vesicovaginal fistulas involves dissection of an outer vaginal sheath originating 3 cm under the fistula opening. The sheath is dissected completely away from the sides of the vagina so that it obtains maximum blood supply. The dissection from the adjacent vaginal layer is carried to within ~0.5 cm of the fistula opening. Thus isolated, the sheath is then invaginated into the bladder and sutured to its surface. Absorbable suture material is used to join the bladder surface and a fine metallic thread is used for the central suture. The vagina is then closed off from underneath. In all cases a permanently in-dwelling sound was inserted. The rectovaginal fistula was treated in the same way as above, after stopping peristalsis in the colon. The vaginal sheath in this case was invaginated into the rectum thus preventing the formation of a diverticulum. In all cases the results were good, urinary and fecal incontinence disappearing. (BBB)

4955 TUMOR INDUCTION IN HYPOPHYSEAL GRAFTS IN RADIOTHYROIDECTOMIZED MICE: HYPOTHALAMICO-HYPOPHYSEAL RELATIONSHIPS. Kelly H. Clifton (Univ. of Wisconsin, Madison). Proc. Soc. Exptl. Biol. Med., 114: 559-65(Dec. 1963).

Pituitary glands from intact or radiothyroidectomized mice were grafted beneath the kidney capsules of similar intact and radiothyroidectomized recipients in all 4 donor-host combinations in mice of both sexes and in castrated males. Tumors arose in high frequency in such grafts in intact and in thyroidectomized female LAF_1 mice irrespective of the pretreatment of the donors. Transplantation assays indicated that the tumors arising in such grafts were most probably not thyrotropic in nature, but rather were mammotropic, regardless of the treatment of the first host. In contrast, the tumors arising in the thyroidectomized host pituitaries in situ were typically thyrotropic in behavior. No tumors were found in subcapsular pituitary grafts in intact or gonadectomized C57B1/6 male mice, and a small mass (5.5 mg) of as yet unknown character was found at the graft site in but one of 18 thyroidectomized males. The pituitary glands in situ of all of the thyroidectomized males were, however, tumorous. It is tentatively concluded that immediate circulatory connection with the hypothalamus is important in, and probably essential to, the induction of dependent thyrotropic tumors. The possibility that the cells capable of thyrotropic tumor formation did not survive the transplantation seems much less likely. The transformation of a normal thyrotropic cell into a dependent tumor cell thus appears to involve a change in the requirement for, or response to, hypothalamic factors. The role of hypophyseal irradiation in induction of thyrotropic pituitary tumors by radiothyroidectomy with I^{131} was not further clarified. (auth)

4956 EFFECT OF ENDOTOXIN-TOLERANCE, CORTISONE, AND THOROTRAST ON RELEASE OF ENZYMES FROM SUBCELLULAR PARTICLES OF MOUSE LIVER. Aaron Janoff and B. W. Zweifach (New York Univ., New York). Proc. Soc. Exptl. Biol. Med., 114: 695-8(Dec. 1963).

Carbon tetrachloride-induced leakage of 2 acid-hydrolases from mouse liver lysosomes, in vitro, was inhibited by chronic pretreatment of the mice with endotoxin. Cortisone-pretreatment inhibited the release of one of the enzymes. Pretreatment of the mice with Thorotrast, a reticulo-endothelial-blocking agent which neutralizes tolerant states, had the opposite effect and caused accelerated release of acid-hydrolases from liver lysosomes of tolerant as well as normal animals. None of the 3 agents studied produced comparable changes in the rate of leakage of soluble dehydrogenases from mouse liver mitochondria. It is suggested that stabilization of hepatic lysosomal membranes in endotoxin-tolerant animals represents a selective response of these particles to repeated small doses of the toxin and plays an important role in the development of tolerance to this agent. (auth)

4957 RESEARCH ON THE SCIENCE AND TECHNOLOGY OF FOOD PRESERVATION BY IONIZING RA-

DIATIONS. R. S. Hannan. New York, Chemical Publishing Co., Inc., 1956. $4.50.

A comprehensive review is presented on the research conducted all over the world on the use of ionizing radiations for food preservation. Among the topics discussed are: electrically operated generators, waste radiation from atomic energy projects, protection of personnel, radiation effects on microorganisms, radiation effects on important constituents of foods, sterilization of animal products, vegetables, fruits, and miscellaneous products, and incomplete sterilization and other low-dose procedures. (D.L.C.)

Ecology

4958 (JPRS-21989) RADIOACTIVE ISOTOPES AND FISH. Translated from Rybn. Khozy., No. 5, 40-3; 62-4 (1961). 11p. (OTS-63-41204)

Two papers are included; separate abstracts have been prepared for each. (H.M.G.)

For abstracts of individual papers see: 5148 and 5698.

4959 THE ACCUMULATION OF RADIOACTIVE CESIUM BY MARINE INVERTEBRATES. G. W. Bryan (Marine Biological Association, Plymouth, Eng.). J. Marine Biol. Assoc. U. K., 43: 519-39(1963).

Accumulation of radiocesium (Cs^{134} and Cs^{137}) and the relation of this to the uptake of radiopotassium and to the distribution of inactive K in the tissues of marine animals were studied in many species from the major groups of invertebrates during a survey of the possibility that some species might show particular ability in concentrating Cs. In whole specimens of all species examined radiocesium was always absorbed more slowly than K^{42} from sea water. All the inactive K in these species appeared to be readily exchangeable with K^{42}, but, at equilibrium, concentration factors for Cs^{137} usually exceeded those for K^{42} or inactive K. In sea anemones, the shore-living Actinia and Tealia were not less permeable to Cs than Metridium and Calliactis, which were taken from deeper water. In these animals the highest concentration factors for Cs^{137} and inactive K were found in the tentacles. Greater differences were found between the rates of Cs^{137} uptake in the polychaetes Nereis diversicolor and Perinereis cultrifera. This is likely to be related to the fact that Nereis is a brackish water species, which is more euryhaline than the more marine Perinereis, and judging from results obtained with other brackish water animals, Nereis would be expected to reach higher equilibrium concentration factors for Cs^{137} in diluted sea water. The most rapid uptake of Cs^{137} was found in the smallest animal studied, Tisbe reticulata; half the equilibrium concentration factor of 12 is reached in about 2.0 hr at 20°C. Calanus, which is a much larger copepod, absorbs the isotope more slowly and half the equilibrium concentration factor of about 14 (the highest value noted in any species studied) is reached in 20 hr at 9°C. It is concluded that in species having body fluids, uptake of radioactive Cs into the body fluid is rapid and equilibrium concentration factors of the order of 1.0 are found. These factors are similar to those for inactive K. Soft tissues tend to reach variable radioactive Cs concentration factors of the order of 10, which at equilibrium exceed those for inactive K or K^{42}. (BBB)

4960 CAESIUM-137 CONTENT OF FRESH-WATER FISH IN FINLAND. Erkki Haesaenen and Jorma K. Miettinen (Univ. of Helsinki). Nature, 200: 1013-19(Dec. 7, 1963).

Determinations were made of the Cs^{137} and K contents of samples of fish from Finland. The fish were caught during the period 1961 to 63. The fish were dried and ground and their activity measured. The Cs^{137} content of various fish species varied from 0.6 to 6 nC/kg. Fish containing more than 2 nC/kg were fish of prey, while those of lower activity, graylings and whitefish, feed on insects, insect larvae, and plankton. The activity appeared to rise in 1962. (M.C.G.)

4961 VEGETATIONAL ANALYSES IN A CREOSOTE BUSH COMMUNITY AND THEIR RADIOECOLOGIC IMPLICATIONS. William H. Rickard (General Electric Co., Richland, Wash.). p.39-44 of "Radioecology." New York, Reinhold Publishing Corp., and Washington, D. C., American Inst. of Biological Sciences, 1963.

Detailed vegetational analyses were conducted on fifteen 50 × 100 feet permanent plots in a creosote bush (Larrea divaricata) community in Jackass Flats, Nye County, Nevada, in 1959 and 1960. Creosote bush dominated the canopy-coverage provided by 11 shrub species and two species of bunch grasses by contributing 6.1% of the total 13.7% ground cover. As creosote bush dominated the ground cover provided by shrubs, Chaenactis stevioides dominated the herbaceous understory vegetation. The amount of ground cover provided by annual species varied from year to year. Twice as much coverage was provided by understory plants in 1960 as in 1959, and the increase related to the more abundant and prolonged precipitation of the winter-spring growing season of 1960. In April 1960, the total ground cover of combined overstory and understory plants amounted to 26.7%, about equally divided between the two groups. Forty herbaceous species were recorded on the study plots in 1960. The amount of ground covered by vegetative canopies, the contributions of each species to ground cover, the development and seasonal persistence of understory layers and the phenological sequence of leaf development and abscission are believed directly related to the vegetative retention of radioactive fallout by desert shrub communities. These synecological features as well as the kinds and abundance of livestock forage plants are of concern in radioecologic investigations because contaminated vegetative surfaces are recognized as the primary source of readily available radioactive fallout to all kinds of herbivorous animals. (auth)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 5218 and 5631.

4962 (UCRL-10966) SULFATE REDUCTION BY BACTERIA. Mark Leban and Charles R. Wilke (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 28, 1963. Contract W-7405-eng-48. 90p.

A comprehensive survey of literature dealing with sulfate-reducing bacteria was made. Data were collected on metabolism, ecology, isolation, and cultivation of these bacteria. It was found that quantitative data on the bacterial reduction of sulfate are almost nonexistent. Desulfovibrio aestaurii, a species of sulfate-reducing bacteria, was isolated from a mud sample obtained from a saltern. Isolation was complicated by an unknown straight rod bacteria, but was eventually achieved through the dilution method and

through the diffusion method. The isolated bacteria were grown in batch experiments to measure bacterial counts and sulfide concentrations. From the experimental data the sulfate reduction rates in complex and simple lactate media were calculated. Correlations were set up expressing reduction rate in terms of growth rate and bacterial density. Reduction rates in a continuous cultivator were estimated. With another set of experiments the effects of initial sulfate content on the sulfate reduction rate, and on percentage conversion were studied. Also investigated was the effect of NaCl concentration on the reduction rate. A gradual adaptation of bacteria to higher salinities was carried out to reduce their NaCl sensitivity. (auth)

4963 (UCRL-11033(p.1-11)) PRELIMINARY REPORT ON STUDIES OF ERYTHROPOIESIS AND ADRENAL-CORTICAL FUNCTION ON MT. EVEREST. William E. Siri (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Results are reported from studies of physiological adaptation to extended intervals of submarginal environmental conditions conducted on members of the American Mt. Everest Expedition in the spring of 1963. The studies included observations on plasma-iron turnover to determine the rate of hemoglobin synthesis, assay of erythropoietin in 24-hr urine collected at high altitudes, and changes in blood elements, blood chemistry, and adrenal-cortical function as a result of altitude and duration of exposure. Neither findings nor conclusions are included. (C.H.)

4964 (UCRL-11033(p.69-74)) SEDIMENTATION PROPERTIES OF NUCLEATED AND NONNUCLEATED CELLS IN NORMAL RAT BONE MARROW. Howard C. Mel (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

The sedimentation properties of nucleated and nonnucleated cells in normal rat bone marrow were compared. The sedimentation was carried out using a stable-flow free boundary method (STAFLO). The fractions were also analyzed microscopically. (C.H.)

4965 (UCRL-11033(p.75-82)) DIFFUSION-GRAVITY CONTROLLED ENZYME-SUBSTRATE REACTION. Howard C. Mel (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

The phenomenon of induced microconvectional instability, or droplet sedimentation, in a continuous flowing system was investigated in experiments using it to control a steady-state model enzyme-substrate reaction. In this system, under conditions defined by the diffusion coefficients of inert constituents, the force of gravity induces mass transfer of lysozyme into its physically separated substrate, giving rise to the reaction. The mass transfer process results from the outcome of a molecular race occurring on the way to diffusional equilibrium, starting from an initially stably layered density gradient system. Results of experiments using a stable-flow free-boundary method (STAFLO apparatus) showed that competitive diffusion and normal gravity interact to transport lysozyme rapidly into its separated substrate in an initially stably layered, flow-system. A continuous steady-state enzyme reaction is thus controlled by gravity and the diffusion coefficients of inert components. Should this transport mechanism play a role in any biological function, then in weightlessness the function would be altered or removed. (C.H.)

4966 (UCRL-11033(p.83-98)) CONVECTION IN LOW GRAVITATIONAL FIELDS. Milton J. Polissar (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

An apparatus is described that was devised for use in studies of convection in low gravitational fields. Preliminary results are reported from studies of the effects of temperature on convection through a cylindrical tube in a two-liquid system. Applications of results in studies of the probable effects of weightlessness and low gravitational fields upon living cells and larger living entities are discussed. (C.H.)

4967 (UCRL-11033(p.99-117)) PATTERNS OF HIGH- AND LOW-DENSITY LIPOPROTEIN DISTRIBUTIONS IN MAN. Alex V. Nichols, Robert K. Tandy, and Oliver F. de Lalla (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

High- and low-density ultracentrifugal lipoprotein data for a healthy human population were evaluated in terms of their distribution properties. Appreciable and significant differences in the relative constellations of mean serum-lipoprotein concentrations appear at the extremes of the distributions determined for specific lipoprotein species. The implications of these distribution data for health and disease are discussed. (auth)

4968 (UCRL-11033(p.118-25)) A CYTOPHOTOMETRIC METHOD FOR STUDY OF THE ERYTHROID DEVELOPMENT SEQUENCE IN MAMMALS. Lawrence R. Adams and Charles A. Sondhaus (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A photographic cytophotometric system for measurements of hemoglobin and nucleic acid in single cells of the erythrocyte precursor series was developed. Preliminary applications in studies of the sequence of erythroid development are described. (C.H.)

4969 (UCRL-11033(p.130-8)) USE OF A WHOLE-BODY COUNTER IN TURNOVER STUDIES WITH Ca^{47}. Thornton Sargent, John A. Linfoot, Henry Stauffer, and John H. Lawrence (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A whole-body counter was used to study Ca^{47} turnover in normal subjects, in patients with metastatic breast cancer, and in patients with acromegaly. Patients with osseous metastases of breast cancer have greatly increased turnover rates. Patients with acromegaly have increased retention of Ca, presumably in bone, and the extent of increased retention seems to correlate with the severity of the disease. (auth)

4970 (JPRS-22295(Del.)) CALCIUM AND PHOSPHORUS DIETARY SUPPLEMENT AS A MEANS OF REDUCING STRONTIUM-90 ACCUMULATION IN SKELETAL BONES. V. A. Knizhnikov and P. F. Bugryshev. Translated from Vopr. Pitaniya, 22: No. 6, 56-62(Nov.-Dec. 1963). 12p. (OTS-64-21025(Del.))

When a Ca supplement is added to the diet of rats, when Ca content in the diet is either low or normal, there is a 33.33 to 50% reduction in deposit in bone tissue of the Sr^{90} entering the gastrointestinal tract. The protective effect of a Ca supplement in the diet is governed primarily by the processes, in the gastrointestinal tract, of dilution and carrying away of Sr^{90} together with the excess unassimilated Ca. The greater the Ca content in the diet, the lower its assimilation and the lesser the preference given it over Sr. Apparently the processes producing the protective action of nutrient Ca are not purely mechanical and are subject to regulatory mechanisms of the organism. The highest relative protective effect was observed when the Ca supple-

ment did not exceed by more than two to four times the normal Ca content in the diet. When P was added to the diet in quantities producing a P/Ca ratio not exceeding 1:1, the protective action of the Ca supplement was enhanced. A Ca supplement in the diet not only reduced Ca^{45} deposit but also increased excretion of this isotope from the skeletal bones, and apparently of Sr^{90} as well. (auth)

4971 WHOLE BODY AUTORADIOGRAPHIC STUDIES OF THE DISTRIBUTION OF SULPHUR 35-LABELLED MUSTARD GAS IN MICE. C.-J. Clemedson, H. Kristoffersson, B. Soerbo, and S. Ullberg (Research Inst. of National Defence, Sundbyberg, Sweden; Royal Veterinary Coll., Stockholm; Univ. of Gothenburg, Sweden; and Medical Nobel Inst., Stockholm). Acta Radiol., (NS) 1: 314-20(Oct. 1963).

Mustard gas labeled with S^{35} was applied to the skin of mice and also given by intravenous injection. The distribution of the radioactivity was followed by whole-body autoradiography. A high uptake was found in the kidneys and liver; the nasal region rapidly accumulated a high activity, and considerable activity was also evident in the central nervous system. Some experiments in pregnant animals demonstrated a passage of radioactivity to the fetuses. (auth)

4972 X-RAY SPECTROSCOPY IN BIOLOGY AND MEDICINE. V. TOTAL SERUM IODINE. Paul K. Lund and James C. Mathies (Pacific Northwest Research Foundation, Inc., Seattle). Am. J. Clin. Pathol., 40: 132-5(Aug. 1963).

A rapid, simple technic for the estimation of total serum iodine by means of the x-ray spectrograph is described. Iodine Lα radiation is quantitated, using 50-μl specimens of serum dried in a thin film on an albumin planchet. The procedure is designed for routine use as a cross-contaminator screen for the determination of protein-bound iodine. It allows detection of every serum capable of yielding cross-contamination. Model experiments demonstrated the potentially useful application of this test procedure in the assessment of fat absorption after ingestion of triglycerides labeled with nonradioactive iodine, with the advantages that radioactive substances are not administered to the patient, and radioactive decay rates are not factors in timing analyses and calculating results. Similar adaptation of certain other test procedures, now restricted to the use of radioactive tracer techniques, seems to be possible with this principle. For lipid tolerance assessment the test procedure uses iodinated poppyseed oil (Lipiodol) in place of I^{131}-labeled triolein. Total serum iodine was measured for 24 hours following ingestion of 40% Lipiodol with a high fat breakfast. The type of tolerance curve obtained indicates that a practical working procedure can be devised. Measurements of iodine in urine or feces, or both, could also be obtained with equal ease. If the test lipid also contains free fatty acids labeled with bromine, simultaneous differential evaluation of pancreatic function and intestinal absorption is possible by x-ray spectrographic measurement of both total iodine and bromine in the same 50-μl specimen. (BBB)

4973 DEUTERIUM ISOTOPE EFFECTS IN RELATION TO THE CHEMICAL MECHANISM OF MONOAMINE OXIDASE. Bernard Belleau and J. Moran (Univ. of Ottawa). Ann. N. Y. Acad. Sci., 107: 822-39(July 8, 1963).

Tyramine was found to be oxidized at a rate 2.3 times faster (at subsaturation levels) by monoamine oxidase (MAO) than α-d_2-tyramine. This established that the rate-determining step consists in the abstraction of an α-hydrogen. The magnitude of the rate ratio suggests, at first glance, that a fair degree of bond weakening occurs in the transition state for oxidation. Ascribing the in vivo isotope effects to a slower rate of degradation of α-d_2-tyramine by intracellular MAO was justified. The observation that α-d_2-kynuramine is also oxidized more slowly by a factor of 2.1 relative to kynuramine establishes that the rate-determining step in the oxidation reaction is independent of the nature of the substrate, kynuramine representing a substantial structural departure from tyramine. The sharp fall in the magnitude of the isotope effect at high tyramine concentrations (corresponding to maximum velocity) is of considerable significance. The k_H/k_D ratio of 1.2, which was observed under these conditions, suggested that the higher ratio at low tyramine concentration might reflect differences in the respective affinities of the labeled and normal substrates for the enzyme. Evidence supporting this interpretation was obtained by measuring the ratio of the respective Michaelis constants of the tyramine-α-d_2-tyramine pair. (P.C.H.)

4974 COMPARATIVE FIXATION OF CALCIUM AND STRONTIUM BY SNAIL SHELL. R. C. Likins (National Inst. of Dental Research, Bethesda, Md.); E. G. Berry, and A. S. Posner. Ann. N. Y. Acad. Sci., 109: 269-77(May 31, 1963).

Strontium and Ca uptake by biologically formed aragonite was investigated in the fresh water pulmonate snail Australorbis glabratus. The results show a marked discrimination against Sr relative to Ca in new shell formation which decreased as the Sr/Ca ratio of the solution was increased. Preformed shell also discriminated against Sr but to a lesser extent. Conversely, snail-free shell took up Sr preferentially as did powdered shell in an in vitro exchange study. Aragonite and calcite precipitated from Ca solutions containing Sr^{89} and Ca^{45} removed equal proportions of these two isotopes. Radiochemical analysis of the snail body also showed a preferential uptake of Ca from solution although the discrimination against Sr was less than for shell. X-ray diffraction analyses of Sr containing shells showed this ion to be substituted isomorphously for Ca in the aragonite structure. The discrimination against Sr relative to Ca in the living snail is primarily the result of metabolic processes with the possibility of some crystallographic differentiation. (auth)

4975 UPTAKE, TURNOVER AND TRANSPORT OF BONE SEEKING ELEMENTS IN FISHES. Harold L. Rosenthal (Washington Univ., St. Louis). Ann. N. Y. Acad. Sci., 109: 278-93(May 31, 1963).

The rate of uptake of Ca^{45}, Sr^{90}, and S^{35} from the water in which they swim is linear with time for the male guppy (Lebistes). Similar results were obtained for the uptake of Ca^{45} and Sr^{90} by white cloud mountain fish (Tanichthys) and zebra fish (Danio) of mixed sexes. The rate of incorporation of the nuclides is also linear with time for various tissues of the body such as muscle, viscera, head and spine, but the distribution of the nuclides varies with the nature of the tissue and the element involved. The rate of uptake was found to be a function of the concentration of the nuclide in the water at constant ionic concentration. A series of double tracer experiments, using Ca^{45} and Sr^{90}, indicated that fresh water fishes have little ability to discriminate between Sr and Ca when the isotopes are taken up from the water in which they swim. (C.H.)

4976 CHANGES IN TRACE METALS IN BRAIN IN HUNTINGTON'S CHOREA. Cyril B. Courville, R. E. Nusbaum, and E. M. Butt (Loma Linda Univ., Los Angeles). Arch. Neurol., 8: 481-9(May 1963).

In 18 normal brains and three from chorea patients, evaluation of 13 trace elements (including Sr) was done by an emission spectrochemical method to determine whether there is any correlation between cortical areas of known function and deposition of the elements. Of the 13 metals analyzed, only 5 (Cu, Fe, Sr, Ca, Zn) are discussed since concentrations of the other eight did not differ among cases. Strontium was increased in brain in Huntington's chorea and Cu decreased. Quantitative alterations were also found in the concentrations of Zn, Ca, and Fe. Trace metal deposition in the brain is related to the composition of the tissues (gray matter vs white matter), rather than to specific areas of function. In chorea, Cu and Zn fell below the mean by about two standard deviations, while Sr concentrations rose above the mean by about the same amount. Deviations from the mean for Fe and Ca were smaller. Average Sr concentrations in various parts of normal brain were 0.06 to 0.07 ± 0.04 (S.D.) mg/100 g dry tissue. Copper values were low in all parts of the brain in both early and advanced cases of Huntington's chorea. Zinc and Fe were altered little in the early cases but were low in the advanced stage. Calcium was decreased in one and elevated in two cases. This study did not indicate whether cellular or structural changes are due to a metabolic factor incident to decrease in Cu, Fe, and Zn, or to increase in Ca and Sr. These changes may simply be markers of Huntington's chorea and not an indication of the mechanism by which the causative metabolic factor is produced. (BBB)

4977 OCCUPATIONAL DERMATITIS DUE TO SENSITIZATION TO SODIUM AND CALCIUM URANYL CARBONATES. H. Thiers, G. Chanial, and J. Rivoire. Bull. Soc. Franc. Dermatol. Syphilig., 68: 142-4(1961). (In French)

A report on a rare type of occupational dermatitis from sensitization to Na and Ca uranates observed in two workers in the Guegnon uranium-processing plant is presented. In both patients there was no history of personal or family allergies. The dermatitis was especially evident on the fingers and presented characteristics not reported previously: the skin was dry and wrinkled with small periungualar fissures. Small nodules 2–3 mm, appearing as centers of hyperkeratosis encased in the skin, appeared on the sides and under surface of fingers. The nails were grooved and peeling at the edges. Also, at the base of the fingers and over the hand hyperkeratosic eczema of a common type was seen. These lesions were filled with pus. Skin tests confirmed their sensitization to 2% solutions of Na and Ca uranates; otherwise these patients appeared to be completely normal. A survey of working conditions showed that there was no possibility of their dermatitis resulting from radioactivity. That excessive radiation was not involved in the pathogenesis of these lesions was attested to by their normal blood pictures. The manifestations of the lesions indicated their definite allergic origin. Both patients recovered eventually and, after occupying other positions in the plant, have had no recrudescence of the lesions. (BBB)

4978 PLASMA VALUES AFTER ORAL CALCIUM-45 AND STRONTIUM-85 AS AN INDEX OF ABSORPTION. Joseph Samachson (Veterans Administration Hospital, Hines, Ill.). Clin. Sci., 25: 17-26(Aug. 1963).

Plasma values after intravenous and oral doses of Sr^{85} and Ca^{45} were used to permit a more rapid determination of absorption. Patients received intravenous doses of 0.1 to 0.4 μC/kg of Sr^{85} or Ca^{45} or both, as the chloride. The Sr^{85} was carrier free; Ca^{45} contained a fraction of a mg of stable Ca per dose. Oral doses were administered with 25 mg of stable Sr as carrier for Sr^{85} and 25 mg of stable Ca as carrier for Ca^{45}. Plasma values of Sr^{85} and Ca^{45} were compared in 44 patients after 76 intravenous and 71 oral doses, with particular emphasis on values obtained the first day. In patients receiving several intravenous doses, plasma values were reproducible despite differences in treatment. The values of 1, 4, 8, and 24 hours depended chiefly on passage from plasma into other body compartments, the influence of urinary excretion in lowering Sr^{85} plasma values becoming evident at 24 hours. Absorption was essentially complete in 4 hours. The percentage of radioisotope absorbed could be determined from plasma values of Sr^{85} and Ca^{45} as well as from stool values. When absorption was low, determination from plasma was more accurate. In general, agreement between absorption calculated by the two methods was good. The average difference between values determined from plasma and stool was 0.99 with a standard error of 0.93. The Sr^{85} absorption, as estimated from the 8 and 24 hour values, was 45-7% of Ca^{45} absorption on a low Ca diet and 55-6% on a high Ca diet. The addition of Ca to a low Ca diet, thus, caused a greater relative decrease in the absorption of Ca^{45} than of Sr^{85}. The Sr^{85}/Ca^{45} ratios after 1 hour were significantly lower than after 4 hours on both high and low Ca diets. On a low Ca diet, only about ⅓ as much Sr^{85} was absorbed as Ca^{45} in the first hour, although by 4 hours about ½ as much was absorbed. (BBB)

4979 THE VARIATION OF THE FISSION PRODUCT CONTENT OF CYSTOSEIRA IN THE BLACK SEA. V. V. Glazunov, V. P. Parchevskii, and D. G. Fleishman (Kovalevskii Sevastopol Biological Station and Sechenov Inst. of Evolutionary Physiology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 1222-4(Oct. 11, 1963). (In Russian)

Samples of brown seaweed (Cystoseira barbata) were counted after ashing on end-window beta counters having window thicknesses of 1.5 and 5 mg/cm^2. The γ-energies of the activities were also determined on a 99-channel γ-scintillation counter equipped with a NaI(Tl) crystal 70 × 45 mm. Samples were taken from 1957 to May of 1960, and the activities were compared with a museum sample taken in 1939. The level of radioactivity in the sample increased from 1957 to a maximum in the summer and autum of 1959, and dropped sharply in 1960. An analysis of the γ spectra showed that most of the radioactivity in the seaweed was due to the $Ce^{144}-Pr^{144}$ peak at 130 kev energy. Smaller peaks due to $Zr^{95}-Nb^{95}$, Ru^{103}, $Ru^{106}-Rh^{106}$, and K^{40} were also observed. The activities in the ash in units of 10^{-10} curies/g for seaweed collected in September of 1959 were 3.00 for $Ce^{144}-Pr^{144}$, 0.70 for $Zr^{95}-Nb^{95}$, 1.30 for Ru^{103}, and 0.70 for $Ru^{106}-Rh^{106}$. The figure for $Ce^{144}-Pr^{144}$ had dropped to 0.17 for seaweed collected in November of 1960. The results indicate that fission products accumulate in seaweed, and are removed from the water, as the seaweed dies and settles out in the sediment. (TTT)

4980 VALIDATION OF INSORPTION BY BLOOD ANALYSIS WITH COMPARISONS OF SYSTEMIC AND PORTAL VENOUS DISSAPPEARANCES OF D_2O, Na^{24}, AND K^{42}. Charles F. Code, Johann C. Moll, and Alan L. Orvis (Mayo Clinic and Mayo Foundation, Rochester, Minn.). J. Appl. Physiol., 18: 829-33(July 1963).

Rates of disappearance of D_2O, Na^{22}, and K^{42} from the arterial blood were determined in dogs following rapid injection of the isotopes into the femoral and portal veins. Differences between systemic and portal venous injections

were significant during the early phases of the disappearance of the isotopes. Systemic insorption was simulated by continuous intravenous injection of D_2O, Na^{22} and K^{42} at known rates into the femoral vein. The appearance of the isotopes in the arterial blood was determined repeatedly during and after their injection. The rate of injection (simulated insorption) was calculated using the mean systemic arterial disappearance rate. The differences between the calculated and actual rates of injection were insignificant. When portal insorption was simulated by constant injection of the isotopic into the portal vein, the calculated rate of injection was not significantly different from the actual rate if the mean portal arterial disappearance curve was used in the calculation. When the systemic arterial disappearance curve was utilized, the calculated rate of injection was slightly faster than the actual rate. These errors are not large and are consistent; corrrections factors therefore may be employed to improve the estimates of portal insorption when systemic arterial disappearances must be used. Such a correction cannot be used if insorption is not completed during the period of observation. Under these circumstances, correction by the factor calculated in these tests (0.86%/min) might be employed. However, the factor obtained in the dog may not be the same in other species. (BBB)

4981 ELECTRON MICROSCOPIC STUDY ON SPECIFIC PROTECTION OF ISOLATED BORDETELLA BRONCHISEPTICA ANTIBODY DURING EXHAUSTIVE LABELING WITH URANIUM. Ludwig A. Sternberger, Edward J. Donati, and Catherine E. Wilson (Army Chemical Center, Edgewood, Md.). J. Histochem. Cytochem., 11: 48-58(Jan. 1963).

The labeling procedure described involves three steps: removal of antibody from antiserum by agglutination with bacteria; exposure of the washed agglutinate to relatively large amounts of U salts, the specific combining regions of the antibody in the agglutinate now being protected by antigen; and dissociation of antibody from antigen by brief treatment with alkali in the cold, yielding thereby specifically purified antibody containing U in its nonspecific areas but possessing specific combining sites free to react. In application of the procedure, anti-B. bronchiseptica antibody was removed from serum by absorption with B. bronchiseptica cells. The washed agglutinate was exposed to 0.145-14.5 mM uranyl acetate solution. The antibody recovered from this agglutinate by brief treatment with 0.1N NaOH at 1°C was 80 to 100% pure and contained 18 to 312 atoms of U per unit of 156,000 molecular weight. The U stained the walls of living or formalin-killed, and the cytoplasm of living B. bronchiseptica. Escherichia coli and mouse spleen cells were not stained. Contrast was diminished when B. bronchiseptica was exposed to unlabeled anti-B. bronchiseptica antiserum prior to U-antibody conjugate. Absorption with B. bronchiseptica, but not with E. coli, abolished the staining capacity of purified U-antibody conjugate. Whole antiserum labeled with U without specific protection, even though retaining some antibody activity, was not suitable as a stain since it deposited a large amount of debris and apparently stained both E. coli and B. bronchiseptica. (BBB)

4982 ELIMINATION OF I^{131} BY WAY OF BRONCHIAL SECRETION. E. Stresemann and W. Schumacher (Freie Universität, Berlin). Klin. Wochschr., 41: 751-2(Aug. 1963). (In German)

The total I^{131} activity in sputum of nine patients previously laryngectomized several months or a year prior to this study was measured. In 12 tests the subjects received 3 g of nonradioactive potassium iodide daily for three days prior to administration of I^{131}. The I^{131} dosage ranged from 8.7 to 151.5 μC, and was given orally as sodium iodide in aqueous isotonic sodium chloride. Total sputum was collected over the ensuing 46-hr period at hourly intervals for the first three hours and at intervals from 5 to 12 hours thereafter. The peak of maximum I^{131} activity in the bronchial secretions was found to be near 10 hours for some, and 20 hours for others. In all cases except three, where elimination was increased, the total I^{131} collected fell sharply during the last 12 hours. Of the total activity administered, 0.01 to 0.4% was found in the sputum. Total iodine in sputum amounted to less than from 9×10^{-12} to 10^{-7} g/l. The nonradioactive iodide given before the I^{131} reduced the thyroidal uptake of I^{131} from the 10 to 60% found in normal healthy individuals down to 1 to 5%. This decreased uptake was reflected in the urinary excertion of I^{131} by the patients. It ranged from 60 to 80% of the dose given. In two patients where the excretion was less than 30% a portion of the total urine was lost. The results indicate that it is improbable that the bronchial mucosa actively secretes iodine, or that hormonal iodine is released into the bronchial secretions. The bronchial iodine appears to be directly proportional to the plasma iodine concentration. The results do not suggest that the iodine concentration found is related to the different volumes of bronchial sputum obtained from the patients. (BBB)

4983 CESIUM-137 LEVELS IN HUMAN BODY, DECEMBER 1961–NOVEMBER 1962. Noboru Yamagata (Inst. of Public Health, Tokyo) and Yumiko Kai. Koshu Eiselin Kenkyu Hokoku, 11: No. 4, 191-6(Dec. 1962).

Post-mortem samples of human breast muscles collected in Tokyo from December 1961 to November 1962 were analyzed for cesium-137 and potassium. The highest monthly averages of cesium-137 in human muscle were 0.201 and 0.156 μμC/g in March and October 1962, as compared with the mean levels of 0.09–0.11 μμC/g. This trend probably reflects the increase of cesium-137 in fallout that resulted from the series of nuclear explosions by the U.S.S.R. in the autumn of 1961. The average estimates of total body burden were 4.3–4.8 mμC for the period. (Public Health Eng. Abstr., 43: No. 11, 1963)

4984 THYROID UPTAKE AND BODY BACKGROUND. Nikulas Kutka, John Porr, and Luciano Semprebene (Università, Rome). Minerva Nucl., 7: 316-17(Aug. 1963).

Radioalbumin and radioiodine, together with Lugol's solution, $KClO_4$, or Tapazole premedication, were used to study the components of thyroid region radioactivity in human subjects. In measuring thyroid uptake, radioactivity from intra- and extra-thyroid vessels and trapped radioactivity contribute to the body background of the neck. The neck-thigh radioactivity ratio after radioalbumin administration was greater than one. The methods commonly used for eliminating the effects of body background of the neck (thyroid shielding, and subtraction of thigh radioactivity or of vessel radioactivity in the thyroid region) are shown to be inadequate. (auth)

4985 USE OF SEMIAUTOMATIC APPARATUS FOR THE EVALUATION, BY MEANS OF RADIOISOTOPES, OF THE BLOOD VOLUME. A. M. Taschieri and C. Puricelli (Università, Milan). Minerva Nucl., 7: 318-21(Aug. 1963). (In Italian)

A new semiautomatic apparatus for the routine measurement of the blood volume using radioisotopes is described. The method is rapid and simple and can be used for re-

peated pre-, intra-, and post-operative determinations. (auth)

4986 PARASITE MIGRATION AND HOST REACTION IN MICE EXPOSED TO IRRADIATED CERCARIAE OF SCHISTOSOMA MANSONI. F. von Lichtenberg and E. H. Sadun (Harvard Medical School, Boston). Exptl. Parasitol., 13: 256-65(June 1963).

Investigations were undertaken to ascertain: what host organs are reached by Schistosoma cercariae γ irradiated at different dose levels; the nature and extent of lesions produced in these host organs; and possible similarities existing between the tissue reactions to irradiated cercariae and those observed previously in natural and acquired resistance. Cercariae were exposed to 2500, 5000, and 50,000 rep doses of Co^{60} γ radiation and immediately injected into mice, the tissues of which were examined for schistosomula 50 days later. Irradiation interfered with the ability of schistosomes to reach maturity in mice. Since the death and disintegration of schistosomula stimulated a considerable degree of inflammation, different dosage levels provided contrasting tissue reactions. At 50,000 rep, cercarial dermatitis with ulceration and marked vasculitis was the main pathologic feature; at 5000 rep numerous granulomatous foci were seen in the lung; and at 2500 rep foci of liver cell necrosis and liver granulomata occurred. Irradiation of 2500 rep appeared to be the best dose since the less heavy concentration of parasites in a single organ produced the least amount of objectionable pathologic changes. The findings confirm that the life span, maturation, and migration of irradiated cercariae are affected in proportion to the irradiation level. No eggs were produced at any of the radiation levels studied. Stunted young adults developed from cercariae irradiated at 2500 rep. These attained their greatest number 40 days after exposure, but by day 50 most of the schistosomula had died, leaving small granulomas and calcified foci as a residue. When cercariae were exposed at 5000 rep, only a few sporadic stunted worms were found in the liver, and with 50,000 rep, most of the schistosomula died in the skin injection site. However, variations of biological vigor were such that even at 50,000 rep some parasites were able to migrate from the skin to the lungs and reach the liver, as shown by one granuloma observed in that organ. (BBB)

4987 IN VIVO INCORPORATION OF TRITIATED THYMIDINE IN ACUTE LEUKAEMIA CHROMOSOMES. F. Gavosto, A. Pileri, L. Pegoraro, and A. Momigliano (Medical School, Turin). Nature, 200: 807-9(Nov. 23, 1963).

The in vivo incorporation of tritiated thymidine into the chromosomes of a patient with acute leukemia was investigated. Ten mc of tritiated thymidine was injected intravenously. 50.6% of the mitotic figures (out of a total count of 420 mitoses) showed evidence of labeling: owing to the experimental conditions, tagged mitotic figures could only be found in the cells that had incorporated the precursor in the final stages of the synthetic period, whereas the unlabeled figures correspond to cells that were past the S stage at the time of labeling. From the results it was concluded that: duplication of DNA follows not a random course but a particular time sequence not only in normal blood cells but also in acute leukemia cells. The time sequence presents the same features in euploid cells as in aneuploid cells. Incorporation of the DNA precursor was also achieved by the extra-chromosomes. The synthetic phase of the Y chromosome in the present case of acute leukemia differed from that of the small acrocentric chromosomes. The ratio of labeled to non-labeled mitotic figures suggested the possibility that the post-synthetic period is shorter in vivo than in vitro. (P.C.H.)

4988 ATTEMPT TO ACCELERATE THE EXCRETION OF RADIOIODINE FROM BODY OF EXPERIMENTAL ANIMALS. Kai Setaelae and A. O. Kuikka (Univ. of Helsinki). Naturwissenschaften, 50: 664-5(1963).

The withdrawal of radioiodine from mice, utilizing the extrarenal mineral/fluid-balance regulatory system as a motor for excretion, is reported. A calibrated quantity of 0.5 μc of I^{131} was instilled intragastrically in a single dose in female mice. The extrarenal system was activated by the injection of 3 mg of pilocarpine. The saliva, stool, and cutaneous gland excretion were collected and examined for radioiodine concentration. The I^{131} was rapidly picked up by the thyroid, and the maximum was reached 15 to 45 min after instillation. The radioactivity was excreted both in the urine and the stool. After injection of pilocarpine nitrate, large quantities of I^{131} were excreted through the salivary glands and the excretory glands of the large intestine. Instillation of stable iodine together with specific activation increases the excretion of radioiodine through the extrarenal system. (J.S.R.)

4989 A METHOD FOR DETERMINATION OF THE EXACT LOCALIZATION OF RADIOSTRONTIUM AND FOR CONTINUOUS QUANTITATIVE FOLLOW-UP OF RADIOSTRONTIUM METABOLISM IN A LIVE ANIMAL. Kai Setaelae, A. O. Kuikka, and Otto Nyssoenen (Univ. of Helsinki). Naturwissenschaften, 50: 668-9(1963).

The principles of a method for the quantitative follow-up of the internal metabolism of radiostrontium in live mice are outlined. The caudal spine of the mouse was used as the target tissue. The living mouse was placed in a perspex chamber, and its tail was straightened out and immobilized with plaster to a foundation plate. A synchro motor was used to move the detector or the mouse. Roentgenograms of the caudal spine were magnified some 15 times. The apparatus was attached to a measuring instrument equipped with a 1-channel analyzer, a recorder, electronic timer, scaler, rate meter, etc. Beta particles were measured with a miniature G-M tube or with a β scintillator. Preliminary observations justify the conclusion that the method allows quantitative determination of the radiostrontium metabolism in living animals. The removal of radiostrontium from the bone can be followed directly through numerical data, activity values, and percentages. (J.S.R.)

4990 Sr-90 IN HUMAN-BONES IN POLAND. RESULTS FOR 1960 AND 1961. Julian Liniecki and Wieslawa Karniewicz (Inst. of Occupational Medicine, Lodz, Poland). Nukleonika, 8: 401-10(1963).

The concentrations of Sr^{90} per gram of calcium in human bones in Poland over the period from 1960 through 1961 are presented. The peak value in 1960 occurred in bones of ab. 2.5 years old children and amounted to 3.3 pc/gCa. In 1961 the highest mean concentration of Sr^{90} (2.6 pc/gCa) was found in children ab. 1.5 years old. The concentration of Sr^{90} per gram calcium in bones of adults did not vary with age above 30 years and mean values in vertebral bodies in 1960 and 1961 were respectively 1.00 and 1.16 pc/gCa. These values correspond to the average concentration in the skeleton of ab. 0.40 and 0.47 pc/gCa. (auth)

4991 MOVEMENT OF WATER THROUGH SKIN: RATE OF TRANSFER IN AN ATMOSPHERE OF ONE

HUNDRED PER CENT SATURATION WITH DEUTERIUM OXIDE. William A. Neely, M. D. Turner, J. D. Smith, and John Williams (Univ. of Mississippi, Jackson). Surg. Forum, 12: 13-14(1961).

Penetration of D_2O through the skin of dogs was measured by use of an air-tight metal chamber containing the entire body of a small dog, with the exception of the head. A nebulizing system maintained a saturated atmosphere within the chamber and drew its fluid from a reservoir lower than the bottom of the chamber. All condensate from the saturated atmosphere was allowed to drain back into the nebulizer reservoir. A small air compressor supplied chamber air to the nebulizer which maintained circulation of the chamber air. The femoral artery and urinary bladder were catheterized, and the anal orifice was closed by sutures. Control blood samples were taken at the beginning of the experiment and after filling the nebulizer reservoir to a constant level of 100% D_2O, or 50% D_2O and 50% H_2O. After the compressor was started, hourly samples of blood were taken and analyzed for D_2O content. The amounts of D in the subject's body water was plotted against time on rectangular coordinates and the slope of this curve measured at 0 time. This slope represented the rate of transfer of D_2O into the body water compartment, and the slope divided by surface area gave the rate of movement per unit area. Measurements in eight dogs revealed that 46 ± 7 g/hr/m^2 D_2O moved into the animal's body water pool. This represents only the unidirectional rate of water movement. It is concluded that under conditions of 100% humidity and at a temperature of 27°C, D_2O movement does take place across the skin into the body water pool. (BBB)

4992 CHANGES IN CHOLESTEROL, TOTAL LIPID, AND LIPID PHOSPHORUS CONTENT OF RAT SERUM AFTER FEEDING IRRADIATED SOYA OIL. Eva Degkwitz and K. Lang (Universitätt, Mainz). Z. Ernaehrungswiss., 3: 164-7(May 1963). (In German)

Refined soya oil was irradiated with 2.5, 10, and 50 Mrad β-ray doses emitted by a Van de Graaff electron accelerator functioning at 1 Mev. The temperature of the oil was kept below 25°C during irradiation. As a result of irradiation, the iodine number of oil decreased while the viscosity progressively increased. It was expected that similar structural changes would occur in the oil from irradiation as a result of autoxidation. Female Sprague-Dawley rats were fed a diet containing 20% irradiated soya oil, unirradiated oil being used for the control group, 53% Mondamin, 2% cellulose, 20% vitamin-free casein, and 5% salt mixture (Shaw diet). The animals fed 10- and 50-Mrad irradiated soya oil showed a slight decrease in food intake and food utilization efficiency in comparison with the control group. The amount of vitamins given to each animal daily was 50 I.U. vitamin A, 45 I.U. vitamin D, 0.45 I.U. vitamin E, 40 μg thiamine, 40 μg riboflavin, 40 μg pantothenic acid, and 20 μg pyridoxine, 400 μg nicotinamide, and 550 μg choline chloride. The feedings were carried out for three weeks. The total cholesterol content of animal serum consuming 10-Mrad irradiated soya oil was reduced from a control level of 43.1 to 35.6 mg%, the total lipid content rose from 240 to 300 mg%, and the lipid phosphorus content from 3.85 to 4.14 mg%. Animals receiving 50-Mrad irradiated soya oil did not show any change in the lipid components of serum, although they exhibited decreased resorption of the irradiated oil, as shown by the 2-fold increase in fecal lipid. (BBB)

4993 METABOLIC AND TOXICOLOGIC STUDIES OF WATER-SOLUBLE XENON COMPOUNDS. A. J. Finkel, C. E. Miller, and J. J. Katz (Argonne National Lab., Ill.). p.309-14 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Observations were made on the metabolic and toxicologic effects on mice of injections of aqueous solutions of sodium xenate. Sodium xenate was found to be moderately toxic when injected intravenously, and the median lethal dose lies between 15 and 30 mg/kg. The administered sodium xenate appears to be rapidly reduced to xenon gas, and by the use of radio xenon and sensitive detection equipment, it is shown that the bulk of the xenon gas leaves the body within minutes after injection. (auth)

4994 THE TOXICOLOGY OF RADIOACTIVE SUBSTANCES. VOLUME 2. Radioactive Cobalt, Sodium Phosphorus and Gold. A. A. Letavet and E. B. Kurlyandskaya, eds. Translated by R. E. Travers from "Toksikologiya Radioaktivnykh Veshchestv," published by Medgiz, Moscow. Elizabeth Lloyd, ed. A Pergamon Press Book. New York, The Macmillan Company, 1963. 196p.

A series of fourteen articles on the toxicology of radioactive substances is presented. Particular attention is given to experiments involving chronic Co^{60} administration. Separate abstracts have been prepared for each article. (H.M.G.)

For abstracts of individual papers see: 4995, 4996, 4997, 4998, 5124, 5125, 5126, 5127, 5128, 5129, 5130, 5131, 5132, and 5133.

4995 FURTHER RESEARCH ON THE TOXICOLOGY OF RADIOACTIVE SUBSTANCES. E. B. Kurlyandskaya. p.1-13 of "Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Two years of experimental work on the chronic effects of Co^{60} on rats and rabbits is reviewed. The main experiment was carried out on rabbits. In total, five groups of animals were included in the chronic experiment (continuing for two years). The first group of 10 rabbits received $Co^{60}Cl_2$ in a daily dose of 1.25 μC/kg weight. The second group of 13 rabbits received 12.5 μC/kg of $Co^{60}Cl_2$ daily. The third control group of five rabbits received daily 1.9 γ of stable cobalt, corresponding to the quantity of cobalt (calculated for the metal) given to the rabbits of the first group. The fourth group (five rabbits) was a control for the second group and received 19 γ of stable cobalt daily. The fifth group of 10 rabbits served as a biological control. A sixth group of rabbits, which received for two months a large dose of Co^{60}, 65 μC/kg (87 γ stable cobalt), was included in the experiment for particular tests (dosimetrical, biochemical, etc.). The pH of the $Co^{60}Cl_2$ solution was brought close to neutral. Systematic observation was maintained on the animals' general condition and the following factors were studied: absorption, excretion, and distribution of Co^{60} at different periods during administration and determination of tissue doses; the state of the hemopoietic system (peripheral blood and bone marrow by intra-vitam puncture) with application of functional stresses (bleeding, parturition); capillary permeability of eyes and skin; electrocardiographic changes during the intoxication period of administration and also during application of functional stresses (Aschner's test, olfactory-cardiac reflex with inhalation of ammonia, pharmacological tests); certain aspects of protein metabolism (total protein, its separate fractions, residual nitrogen); certain aspects of carbohydrate metabolism (blood sugar, glycogen content and its ease of breakdown by β-amylase, activity of phosphorylase and hepatal amylase); morphological changes;

methods for stimulating excretion of Co^{60} from the body; and the long-term effects of both Co^{60} and intratracheal injection of Na^{24}, P^{32} in the form of chromium phosphate and colloidal Au^{100}. (auth)

4996 ^{60}Co METABOLISM IN RATS AND RABBITS AFTER SINGLE ADMINISTRATION AND CALCULATION OF BODY DOSE. G. A. Abrunina. p.14-29 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Subcutaneous injection or oral administration of $Co^{60}Cl_2$ was given to 48 white rats and nine rabbits. Distribution of the isotope was studied in five of the rabbits, the remaining four being housed in special cells where Co^{60} excretion was measured. Rats were sacrificed after 1, 3, 6, 12, and 24 hours and after 5–10 days. Blood for measurement of activity was collected in citrate solution. The liver, kidneys, spleen, lungs, femoral muscles, pancreas, and adrenals were removed for examination. Radioactivity was also measured in the heart, lymph nodes, sex organs, brain, bone marrow, femoral bones, and skull. After subcutaneous injection the radioactivity of the stomach wall and the large and small intestine was measured, and after oral administration the activity of the whole gastrointestinal tract and its contents was measured. With subcutaneous or oral administration of $Co^{60}Cl_2$ to rats the greatest tissue activity is observed in the first 1–3 hr after administration. By both means of administration, specific activity is highest in the liver and kidneys, and also in the pancreas and suprarenals. Specific activity of tissue after subcutaneous injection is 4 to 6 times higher than after oral administration; 17 to 30% of administered $Co^{60}Cl_2$ is absorbed in the intestine. Almost all administered Co^{60} is excreted within a week. Rabbits exhibit similar characteristics of distribution and excretion of Co^{60}. The β-radiation doses in particular tissues, and the mean doses of γ radiation in the body of rats during the first day after administration of 1 μC/g Co^{60} were calculated. (H.M.G.)

4997 ACCUMULATION AND EXCRETION OF ^{60}Co IN ANIMALS AND TISSUE DOSES DURING DAILY ORAL ADMINISTRATION. G. A. Abrunina. p.30-43 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Equilibrium was very rapidly estimated between the administered and excreted quantities of the isotope in rats and rabbits during daily oral administration of $Co^{60}Cl_2$. Body activity of rabbits reached a constant level, with constant intake of Co^{60}, but with increase of the daily activity administered the body activity increased approximately proportionally to the square root of the amount administered. In rats that had received equal amounts of activity of Co^{60} with different amounts of stable cobalt a lowering of the equilibrium level of body activity was detected, approximately proportional to the root of the daily intake of stable cobalt. The mean doses of β and γ radiation in the body of rabbits during daily oral administration of $Co^{60}Cl_2$ were calculated. The greater part of the total dose is γ radiation, especially for organs of the abdominal cavity. For the liver and kidneys the β dose also acquires material significance and must be taken into account in calculating total radiation dose for these organs. (auth)

4998 THE EFFECT OF CYCLOHEXANEDIAMINOTETRA-ACETIC ACID (CDTA) ON EXCRETION OF RADIOACTIVE STRONTIUM AND COBALT. A. A. Rubanovskaya. p.164-73 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Radioactive strontium was injected intraperitoneally at a level of 5 μC per animal. Immediately afterward injected rats and controls were given an intraperitoneal injection of a neutralized solution of CDTA (40 mg per rat) and a simultaneous subcutaneous injection of an equivalent amount of calcium gluconate. A second injection was given an hour after the first. Two days later the rats were killed and the Sr^{89} content of the bones, soft tissues, and excreta determined. No differences were detected in excretion or bone deposition of Sr^{89} between the control and experimental groups. Cobalt-60 was injected intraperitoneally in a dose of 5–8 μC per rat. The calcium disodium salt of CDTA was injected in different doses: a single 40 mg injection or a double injection of 20 or 30 mg. The preparation was injected at various times after Co^{60} administration: immediately, after 30 minutes, 1 hour, 3 hours, or 48 hours. Compared to the controls, excretion in CDTA-injected rats was increased by 26 to 53 percent, the increase being in the urine rather than in the feces. Accompanying increased Co^{60} excretion was a decrease of deposition in tissues and organs. Comparison of the doses used shows that the 40 mg dose gave greatest fixation and excretion. Fractionation of the 40 and 60 mg doses had virtually no effect on the amount of Co^{60} excreted. (H.M.G.)

Radiation Effects

4999 (HW-SA-3226) CHEMICAL PROTECTION OF FOOD PRIOR TO RADIATION-PRESERVATION. Donald R. Kalkwarf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [1963]. Contract AT(45-1)-1350. 10p. (CONF-343-1)

A brief survey is presented of the problems of radiopreservation of foods and of the possible chemical sensitization of the foods toward radiation effects. The effects of food medium on the radiosensitivity of microorganisms and the possible mechanisms of these effects are discussed. The problems of chemical food protection are discussed in relation to those of chemically protecting human beings from radiation damage. (D.L.C.)

5000 (NP-13281(p.1-24)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. THE INFLUENCE OF X IRRADIATION AND CHEMICAL AGENTS ON DETOXIFICATION MECHANISMS. Kenneth P. DuBois and Florence Kinoshita (Chicago. Univ. Air Force Radiation Lab.).

Studies were undertaken to obtain further information on a radioinduced defect in the development of liver microsome enzymes that catalyzes the metabolism of foreign chemicals. The anticholinesterase action of O,O-diethyl-O-(methylthio-m-tolyl) phosphorothioate (DMP) was used as a measure of the influence of various chemical agents and radiation on a detoxification system. The toxicity and anticholinesterase action of this compound is markedly influenced by a detoxification system in the liver. A procedure was developed for using the anticholinesterase action of DMP in adult female rats as a measure of the effects of chemicals and x radiation on detoxification enzymes. Results are tabulated. (C.H.)

5001 (NP-13281(p.25-33)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. II. INFLUENCE OF X IRRADIATION ON THE DEVELOPMENT OF A THIOPHOSPHATE-OXIDIZING

ENZYME SYSTEM IN THE LIVERS OF YOUNG MALE RATS. Bernard E. Hietbrink and Marjorie Keshmiri (Chicago. Univ. Air Force Radiation Lab.).

Studies were undertaken to obtain additional information concerning the mechanisms involved in the inhibitory effect of ionizing radiations on the development of the phosphorothioate-oxidizing enzyme system in the livers of young male rats. The results of experiments on the influence of partial body shielding on the development of enzyme activity indicated that shielding the head and liver area provided a substantial reduction in the degree of inhibition caused by 200 r of x radiation. It was found that the administration of 200 r of x ray to the testes area while shielding the remainder of the body caused a significant reduction in the normal rate of development of microsome oxidase activity. The development of the enzyme activity of the livers of animals given 400 r to the testes area was inhibited to an extent similar to that caused by 200 r of whole-body radiation. Shielding the head while exposing the remainder of the body to 200 r of x ray did not reduce the inhibitory effect of this dose of whole-body radiation. Administration of 200 r to the head while shielding the remainder of the body inhibited development of the drug-metabolizing enzyme to a degree similar to that observed following 200 r or 400 r of whole-body x ray. (auth)

5002 (NP-13281(p.92-103)) INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. I. EFFECTS OF PARTIAL BODY SHIELDING ON THE ACETYLATION OF SULFANILAMIDE IN CHRONICALLY IRRADIATED MICE. A. Sandberg and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

The effect of chronic irradiation on the ability of CF_1 female mice to acetylate sulfanilamide was investigated in situations in which the animals received 50, 100, and 200 r/day of whole-body x radiation, irradiation of the liver area only, or irradiation when the liver area was shielded. The acetylating capacity of the liver was not destroyed when a total of 1,400 r had been accumulated in the groups of mice receiving 200 r/day. After an accumulated dose of 1,300 r in the groups receiving 100 r/day, acetylation of sulfanilamide remained unchanged. There was no impairment of acetylating ability in mice which received 1,100 r given in daily doses of 50 r even though those animals which were given whole-body irradiation were in a moribund condition. (auth)

5003 (NP-13281(p.104-14)) INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA OR FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. II. CAGING AND HOUSING EFFECTS ON MORTALITY IN X-RAYED MICE. D. G. Oldfield, V. Plzak, E. L. Simmons, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

The time-course of mortality in groups of male and female CF_1 mice given a single dose of x rays, housed after irradiation in different but comparable animal quarters, and, at each site, initially caged four animals per plastic, or eight animals per metal cage, does not show large differences. X-rayed animals caged four per plastic cage show an ST_{50} which is 5 to 30% longer than animals caged eight per metal cage. Thirty-day mortality was nearly the same in all groups. The indications for being able to compare radiation mortality data between the two laboratories investigated are favorable. (auth)

5004 (UCRL-11033(p.12-18)) STUDIES ON THE MAMMALIAN RADIATION SYNDROME WITH HIGH-ENERGY PARTICULATE RADIATION. I. DIFFERENCE IN INJURY MODE AND ITS DOSE RATE DEPENDENCE FOR 100-kvp X RAYS AND 730-Mev PROTONS. James K. Ashikawa, Charles A. Sondhaus, Cornelius A. Tobias, Clyde Greenfield, and Jerry Howard (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

The time course of radiation mortality was followed in more than 700 mice exposed to 730-Mev protons at 100 and 1,000 rad/min and an equal number of mice exposed to 100-kvp x radiation at a mid-line air dose rate of 20 and 100 rad/min. In the proton-irradiated mice, peak mortality occurred at 4 and 6 days post-irradiation in the 30-day lethal range and death was attributed to gastrointestinal injury. In mice irradiated with 30-day lethal doses of 100-kvp x rays, peak mortality occurred at 12 to 14 days post-irradiation, and death was attributed mainly to loss of hematopoietic function and all death after 10 or 11 days post-irradiation was considered as bone-marrow death. The marked differences observed in the mode of death was attributed to the difference in tissue-dose distribution in gut and bone marrow between the two radiations, rather than to a change in sensitivity of the mouse intestine with change in LET. (C.H.)

5005 (UCRL-11033(p.41-54)) PRELIMINARY REPORT ON HISTOPATHOLOGICAL CHANGES IN BRAIN FOLLOWING HEAVY-PARTICLE IRRADIATION. Larry W. McDonald, James L. Born, John H. Lawrence, and John T. Lyman (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Observations are reported of histopathological changes in brain in 17 cases of metastatic carcinoma of the breast treated with 900-Mev α particles to the pituitary as palliative therapy. The threshold for observable radiation change in the cerebrum was about 4.0 krad in 11 days of α-particle irradiation in the series of 17 cases. Better correlation was found with an exposure of more than 5.5 krad. The changes at the dose levels of 4 to 9 krad in 11 days appear related to alterations in the vasculoastrocytic unit, with early swelling of cells of the vessel walls, particularly of the small arterioles. Astrogliosis was seen early but was not a prominent feature. Increase in the number of PAS positive bodies was noted with a 5.6- to 9-krad exposure. No definite change could be noted in the nerve cells in the dose range of 4 to 9 krad. A graft rejection type reaction is suggested to account for the delayed necrosis of brain which occurred at doses above 6.0 krad with a survival of over 1,000 days. (C.H.)

5006 (UCRL-11033(p.55-8)) MODIFICATION OF RADIATION EFFECTS WITH MAGNETIC FIELDS. Nabil M. Amer (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A modifying effect of a constant magnetic field on the course of wing development was demonstrated in Tribolium confusum irradiated as pupae using 1,200 r of 250-kvp x rays at rate of 1,000 r/min. The effects of temperature are discussed. (C.H.)

5007 (UCRL-11033(p.59-64)) MULTICOMPARTMENT INTERPRETATION OF RADIATION-DAMAGE CURVES. Aldo Rescigno (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A multicompartment model is described for use in studies of radiation injury in single cells and cell populations. Mikusinski operational calculus is used in calculating radiation injury in three-compartment systems where the structure of a cell is represented by means of an ori-

ented graph and each compartment is represented by an arrow. (C.H.)

5008 (UCRL-11033(p.65-8)) OPERATIONAL CALCULUS IN TWO VARIABLES. Aldo Rescigno (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

An operational calculus is described for use in radiobiology problems that is based on the 2 operations of addition and convolution for which Mikusinski developed an algebra. The method is applicable in many problems involving linear partial derivative equations with 2 variables and may be extended to functions with any number of variables. (C.H.)

5009 (UCRL-11033(p.139-51)) HEAVY-PARTICLE IONIZATION (H, He, Li, B, C, N, O, F, Ne, Ar) AND THE PROLIFERATIVE CAPACITY OF NEOPLASTIC CELLS IN VIVO. Karen Sillesen, John H. Lawrence, and John T. Lyman (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

The relative biological effects of several heavy particles with various energies, nuclear mass, and charge were studied in two neoplasms in mice. Results indicate that the Bragg-peak ionization produced by 910-Mev α particles has a greater RBE than the plateau region of ionization as measured by the proliferative capacity of neoplastic cells grown in the living animal after irradiation. This is of advantage in the use of these particles in therapy. Preliminary results in the same system using various heavy particles producing various LET's indicate that disappearance of the oxygen effect requires a very high LET. Further studies are necessary to define the Z number and energy of the particle with optimal characteristics based on width of the Bragg peak, absence of oxygen effect, and RBE. (C.H.)

5010 (JPRS-22107) PATHOGENIC EFFECT OF LOW AND MEDIUM DOSES OF GAMMA-RAYS ON THE PROGENY OF IRRADIATED INSECTS. V. Ya. Podolyan. Translated from Tr. Inst. Zool., Akad. Nauk Kaz. SSR, 19: 220-5(1963). 8p. (OTS-63-41271)

Data are presented on the effects of low and medium doses of Co^{60} γ radiation on adult spring carrion flies (Protophormia terrae novae) and on the progeny of these insects from the first to the fifth generation. Fifteen experiments used various radiation doses from 100 to 1500 r and combinations of irradiated males, irradiated females, or both irradiated males and females. The mortality rate among insects irradiated with 100 r was higher than that of mature insects exposed to higher doses. The percentage of unfertilized eggs and mortality rate of the preimaginal stages increased with the intensity of the radiation dose to the maternal generation of mature flies. Possible applications of radiation in the control of insect pests are discussed. (C.H.)

5011 (JPRS-22400) CONSEQUENCES OF EXPOSURE TO IONIZING RADIATION DURING PREGNANCY. Nonna Antonovna Kalinina. Translation of "Posledstviya Vozdeistviya Ioniziruyushchei Radiatsii vo Vremya Beremennosti" (a publication of the State Publishing House of Medical Literature, Leningrad, Mar. 7, 1963). 7p. (OTS-64-21087)

Conclusions are presented from a review of the consequences of exposure to ionizing radiation during pregnancy. The radiosensitivity of embryos during the early stages of development and the critical period for various developmental anomalies are discussed. Evidence suggests that radiation affects the embryo both directly and indirectly through the mother. It is suggested that if irradiation occurs during the 2nd to 6th weeks the pregnancy should be terminated. It is concluded that the nervous system of fetuses in mothers irradiated at the end of pregnancy is greatly altered, as shown by inhibition of the respiratory system and feeding difficulties in the offspring. Infection is another serious threat to such infants as immune reactions are greatly suppressed after irradiation. Labor is also seriously impaired by irradiation. Methods of prenatal prevention and treatment of radiation sickness during the various periods of pregnancy are discussed. (C.H.)

5012 INHIBITION OF TRANSPLANTS OF SPONTANEOUS ISOLOGOUS TUMORS IN MOUSE RADIATION CHIMERAS. J. V. Spaerck (Statens Seruminstitut, Copenhagen). Acta Pathol. Microbiol. Scand., 51: 403-15(1961).

The effect of lethal (750-r), whole-body x irradiation of C3H mice, followed by restoration with hematopoietic cells, on the growth of subsequently implanted primary or early passage spontaneous C3H carcinomas was investigated. Liver, spleen, and bone marrow served as sources of hematopoietic cells. It was found that irradiated C3H mice protected with hematopoietic cells acquired increased resistance to the growth of grafted C3H tumors. Acquired resistance to isologous tumors was found to be of the same degree irrespective of whether the chimera was of isologous or homologous composition, or whether the restorative donor material was embryonic liver, adult spleen, or adult bone marrow. This acquired tumor insusceptibility was present to the same extent irrespective of whether tumor challenge was performed three weeks or up to eight months after irradiation. Experiments using sublethal irradiation (550-r) of C3H mice and subsequent challenge of the survivors with isologous spontaneous carcinomas demonstrated that irradiation alone could produce a corresponding tumor-inhibiting effect that persisted for a few months. It is concluded that the observed inhibition of growth in radiation chimeras of spontaneous tumors isologous to the recipient is mainly caused by x irradiation per se, since application of a wide variety of donor material results in tumor inhibition of the same order of magnitude, and since a sublethal dose of x rays without cell replacement also results in long-lasting resistance to this type of isologous tumor graft. (BBB)

5013 SUSTAINED HIGH LEVELS OF ERYTHROPOIESIS-STIMULATING FACTOR(S) IN PLASMA OF IRRADIATED PHENYLHYDRAZINE-TREATED RATS. Erma Eskuche and G. Hodgson (Universidad de Chile, Santiago). Acta Physiol. Latinoam., 12: 282-90(1962).

Changes in red cell counts and plasma erythropoiesis-stimulating factor (ESF) were studied in rats subjected to both whole-body irradiation (550-r, Cs^{137} γ radiation) and red cell destruction with phenylhydrazine. Four groups of rats were used: irradiated rats; rats irradiated and one hour later given one daily subcutaneous injection of 0.3 ml of a neutralized 1% solution of phenylhydrazine hydrochloride for 5 days; rats injected with phenylhydrazine solution (0.3 ml once a day for 5 days); and rats injected with phenylhydrazine solution (0.3 ml once a day for 5 days) and then irradiated after the 5th injection. The results show that preirradiated rats treated with phenylhydrazine become severely anemic and remain so for a period of about two weeks, during which time their plasma shows very high levels of ESF. Rats that receive irradiation after phenylhydrazine treatment show less anemia of similar duration and have lower titers of ESF. The differences between these two groups can be explained on the

basis of the previous finding that treatment of rabbits with phenylhydrazine prior to irradiation had a protective effect on the bone marrow. The experiments suggest a method for obtaining sustained and higher plasma ESF levels than previous methods. Preliminary experiments in irradiated, phenylhydrazine-treated rabbits indicate that the high ESF yields can be obtained from both plasma and urine of these animals. (BBB)

5014 MODIFICATION BY IONIZING RADIATION OF THE CENTRAL NERVOUS REACTIVITY TO STIMULATING DRUGS. V. Grossman, J. Mrazova, and C. Vesely (Charles Univ., Prague). Activitas Nervosa Super., 5: 346-51(1963).

A study was made of the effect of drugs stimulating the CNS in mice, rats, and rabbits during 6 days after irradiation with a mean lethal dose of x rays. It was found that mice showed a lowered intravenous toxicity and increased convulsion to a lethal dose of pentazol, pentazol treated rats had a lowered motor activity after an original hyperactivity, and rabbits showed shortening of the pentazol ECoG changes. Some rats developed a defensive conditioned reflex under standard conditions. These were improved by caffein, methylphenyldat, and benzedrine. It was concluded that radiation probably does not affect definite processes in a special way, but probably disturbs energetic metabolism. (OTS)

5015 FETAL EFFECTS OF RADIOACTIVE IODINE THERAPY IN A PREGNANT WOMAN WITH THYROID CANCER. George C. Hamill, Julian A. Jarman, and Morgan D. Wynne (Maxwell Air Force Base, Ala.). Am. J. Obstet. Gynecol., 81: 1018-23(May 1961).

Injurious effects of I^{131} on a fetus when employed in the eradication of functional cervical thyroid cancer metastasis, follicular type are shown. A woman with cervical metastasis was treated with 77 mC I^{131} when unknowingly three months pregnant. It is estimated that the total-body dose to the mother from this initial 77 mC I^{131} dose approximated 29 rad. The estimate of the blood dose to the mother ranged in the vicinity of 1 rad/mC or 77 rad. The material blood dose is high inasmuch as the patient had minimal circulating thyroid hormone tagged with I^{131}, which would have kept contributing to the thyroid dose after the first few days. Dose calculations regarding the radiation received by the fetus or fetal thyroid were speculative; a minimal or an enormous dose might have been delivered. At premature birth the child had typical immature features but did not have the findings seen in cretinism. Although there was no initial laboratory or clinical evidence of cretinism at $2\frac{1}{2}$ months of age, the observed large tongue, umbilical hernia, retarded ossification centers, and depressed protein-bound iodine determinations established the diagnosis of hypothyroidism. The baby was placed, therefore, on oral thyroid at 83 days of age. Subsequent I^{131} uptake, neck scintigram, and urinary excretion studies showed no functioning thyroid tissue present in the mother following a second 73-mC dose of I^{131}; thus the original purpose of the radioiodine therapy was accomplished. Ascertainment of the pregnancy status in all women prior to I^{131} therapy is advised for prevention of injury to the fetal thyroid. (BBB)

5016 X IRRADIATION OF ROOT MERISTEMS. F. A. L. Clowes (Oxford Univ.). Ann. Botany (London), 27: 343-52(Apr. 1963).

Zea mays seedlings were irradiated when their primary roots were 10-20 mm long at doses of 900 or 1800 rad of unfiltered x rays, given at 113 rad/min from a machine operating at 70 kv. For calculation of the rates of mitosis in the different regions of the meristem the method of metaphase accumulation was adapted. As a measure of the sensitivity of cells to x rays, the proportion of cells with micronuclei was used. After these heavy doses of x rays the average rate of mitosis at first falls in the normally meristematic cells and increases in the quiescent center. Proliferation in the quiescent center gives rise to a new meristem that continues the growth of the root and acquires a quiescent center of its own. Observations on micronuclei produced after irradiation suggest that the quiescent center is less sensitive to x rays than the rest of the meristem. This lower sensitivity, combined with the initial difference in time at which the radiation damage to cell viability occurs, presumably gives the quiescent center its role in the recovery of the meristem. Other evidence indicating this role of the quiescent center in the reconstruction of damaged roots came from autoradiographs made from sections of apices fed with labeled adenine at various intervals after x irradiation. This also showed that in Zea the quiescent center often disappears after irradiation, its cells synthesize DNA, and then divide. Many of the normally meristematic cells, on the other hand, stop synthesizing DNA and stop dividing. It is concluded that the quiescent center is a reservoir of cells that will become meristematic after the normally meristematic cells have suffered genetic death. (BBB)

5017 STUDIES ON RADIATION-INDUCED TANNING OF SKIN. Walter C. Quevedo, Jr., and Jean A. Smith (Brown Univ., Providence and Roswell Park Memorial Inst., Springville, N. Y.). Ann. N. Y. Acad. Sci., 100: 364-89(Feb. 15, 1963).

After repeated exposure to uv, hyperpigmentation developed in the general body skin of hairless mice and in the plantar skin of mice of a number of strains selected on the basis of characteristic differences in coat coloration. The hyperpigmentation was due largely to an increase in melanin synthesis by epidermal melanocytes. The major coat color genes had a profound effect on this process by having an influence on melanocyte distribution and, possibly, proliferation; the numbers of melanocytes activated by uv radiation; the amount of pigment synthesized by melanocytes, either retained by them or transferred to epidermal cells; the color and size of pigment granules elaborated by melanocytes; and the shape of the melanocytes. Possible mechanisms involved in the response of epidermal melanocytes to radiations are discussed. (auth)

5018 THE NATURE OF THE EFFECT OF X-IRRADIATION IN DEPIGMENTATION. Jack Cohen (Univ. of Birmingham, Eng.). Ann. N. Y. Acad. Sci., 100: 400-12 (Feb. 15, 1963).

The depigmentation of hair and feather areas by x rays is discussed. Suggested explanations have involved the assumption that the melanoblasts are directly and quantitatively affected. This view was critically evaluated. Tissue cultures from collars of white feathers growing in follicles that had already produced several generations of such white feathers after irradiation (neck feathers of Brown Leghorn capons), produced melanocytes comparable in numbers and appearance with those of control (pigmented feather) collar cultures. The papillae that had produced such a succession of depigmented feather generations were transplanted to unirradiated breast follicles. Here they continued to produce depigmented neck feather, although some at least were using local unirradiated pigment cells. Unirradiated breast papillae in irradiated neck follicles

produced only normally pigmented breast feathers through seven feather generations. It is suggested that this depigmentation is mediated by the ectoderm concerned and that the action of x rays, in this connection, is upon the melanoblast-ectoderm relationship known to be concerned in many pigmentation processes. (auth)

5019 EFFECTS OF A NUCLEAR DETONATION ON SWINE— BACTERIOLOGIC STUDIES. Howard E. Noyes, Jimmy R. Evans, and Hinton J. Baker (Walter Reed Army Medical Center, Washington, D. C.). Ann. N. Y. Acad. Sci., 105: 651-66(Oct. 24, 1963).

General bacteriological events were followed in a group of swine exposed to a nuclear weapon. The wounds were highly populated by a polymicrobic flora. Pathogenic clostridia were present in many of the wounds, but disease did not result, presumably because of lack of a critical type of tissue damage. The bacterial flora in the wounds diminished after the third day, paralleling the diminution of exudate. Minor depression in the general coliform counts in the feces was observed on D + 3 which had reverted to normal by D + 13. Whether this was a radiation effect could not be determined. Salmonellosis was sporadic. It did not increase following the exposure of these animals to the nuclear explosion. Staphylococci, beta-hemolytic streptococci, and P. multocida were the most frequent organisms invading these animals in the post-detonation period. Some of these organisms arise from sources other than the gastrointestinal tract. A principle of microbic invasion influenced by nuclear weapon effect is suggested. (auth)

5020 ACUTE RADIATION INJURY IN TWO HUMAN FETUSES. Shirley G. Driscoll, Samuel P. Hicks, Edward H. Copenhaver, and Charles L. Easterday (Boston Lying-in Hospital). Arch. Pathol., 76: 113-19(July 1963).

Two cases are reported in which human fetuses, aged 16 and 22 weeks, were exposed to therapeutic radiation and studied pathologically shortly thereafter. These specimens demonstrated that the effects of radiation in the developing human fetus are very similar to those in experimental animals. In the 1st case treatment for cervical cancer consisted of insertion of 50 mg of radium into the cervical canal and 12 units of 5 mg each into the vagina. These were removed 28 hr later, and hysterotomy with removal of the 16-week fetus to interrupt the pregnancy was performed the next day. The estimated dose of radiation was 3900 r at a depth of 2 cm in the paracervical region, and as calculated to the center of the fetal head, 430r. The male fetus was alive at hysterotomy, measured 15 cm from crown to rump, and appeared normal externally. Histologically, the central nervous system, lymph nodes, loose mesenchymal tissues, and kidneys showed noteworthy lesions. In the brain, the proliferating cells, forming the nervous system, were largely destroyed, and the residual tissue of the region was edematous. In lymph nodes there was extensive loss of lymphocytes, and collections of neutrophils with many eosinophils were present within the sinusoids. Loose mesenchymal tissues everywhere showed occasional cells with nuclear pyknosis or fragmentation. Cells with fragmented nuclei were scattered in various tissues, specifically the hypophysis, small intestine, trachea, lung, liver, myocardium, striated muscle, and skin. Placenta and adnexa showed nonspecific microscopic abnormalities, including extensive necrosis and acute inflammation. In the second case, also one of cervical carcinoma, 59 mg of radium was implanted for 100 hr, for a total dose of 5900 mg-hr. The calculated dose to the fetal head was 1600 r, assuming that the head lay 5 cm from the cervix. The living 15-cm fetus was delivered by hysterotomy six days after removal of the radium. Similar significant histological abnormalities were observed. (BBB)

5021 RELATION BETWEEN RADIOSENSITIVITY AND PLOIDY IN MAMMALIAN CELLS CULTIVATED IN VITRO. Guglielmo Marin and Angelo Gino Levis (Università, Padua). Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 34: 204-9(Feb. 1963). (In Italian)

The results of two studies on the relation between radiosensitivity and ploidy using two diverse approaches (comparison between radiosensitivity of isolated strains of different ploidy and an attempt at the selection, by means of irradiation, of strains with numbers of chromosomes greater or less than the mean of the parent population) are reported. The latter was studied with a clone from a stock of human embryonic cells that has a sufficiently wide distribution of number of chromosomes. A culture of the clone was exposed to a single dose of 900 r and to two doses of 900 r each. The results show no significant difference in the mean number of chromosomes or in the percentage of survivals in the two series and in the controls. A strain of cells from a guinea pig kidney was used to determine the radiosensitivity of lines of diverse karyotypes. In this case a culture was exposed to two irradiations of 900 r each. The colony surviving to the second exposure has a chromosome number reduced with respect to that of the parent strain, but the sensitivity to x rays was unchanged. A strain with greater chromosome number than the parent strain was produced using nitrogen mustard. The radiosensitivity of this strain was the same as that of the parent and reduced chromosome-number strains. The significance of these results is discussed. (J.S.R.)

5022 SYNTHESIS OF RIBONUCLEIC ACIDS IN ESCHERICHIA COLI IRRADIATED WITH ULTRAVIOLET LIGHT. A. Sibatani and Nobuko Mizuno (Hiroshima Univ.). Biochim. Biophys. Acta, 76: 188-200(Oct. 15, 1963).

Sensitivity of the synthesis of various RNA components in Escherichia coli B(H) to uv irradiation was examined by chromatographic analysis of nucleic acid samples labeled with P^{32} orthophosphate. After a dose of uv irradiation sufficient to block the DNA synthesis for 30 min, the synthesis of RNA components was not severely affected during the same period. With increasing doses of uv irradiation, RNA synthesis was also impaired progressively, and the order of its sensitivity was that of the increasing molecular weight for transfer RNA and ribosomal RNA. Thus, the synthesis of 23-S RNA was affected most readily, with corresponding inhibition of labeling of 50-S ribosome subunit with C^{14} uracil. Higher doses of uv irradiation completely blocked the synthesis of ribosomal RNA but still allowed some formation of transfer RNA and messenger RNA. No preferential inhibition of the synthesis was observed for any one of the chromatographically separated messenger RNA components. (auth)

5023 THE SYNTHESIS OF RIBOSOMAL RNA IN ULTRAVIOLET-IRRADIATED ESCHERICHIA COLI. H. H. Kroes, Anne-Marie Schepman, and A. Roersch (National Defence Research Organization, TNO, Rijswijk, Netherlands). Biochim. Biophys. Acta, 76: 201-8(Oct. 15, 1963).

The effect of ultraviolet irradiation of whole cells of Escherichia coli strain B on RNA synthesis was studied by fractionation of cell-free extracts in a sucrose gradient in Tris buffer (pH 7.4) and 10^{-2} M Mg^{2+} in the swinging-bucket rotor No. 25 of the Spinco model-L ultracentrifuge. After irradiation with a dose of 200 erg/mm^2 the synthesis

of ribosomes is reduced; the synthesis of 100-70-S and 50-S particles is affected to a greater extent than that of 30-S ribosomes. By fractionation of cell-free extracts in which the protein was removed by phenol extraction it is shown that the synthesis of 23-S RNA is more sensitive to ultraviolet irradiation than the synthesis of 16-S RNA. The higher radiation sensitivity of the synthesis of the heavier ribosomes in comparison with the synthesis of 30-S ribosomes is explained by the 23-S RNA content of the former. (auth)

5024 SENSIBILITY TO X RAYS AND ULTRAVIOLET RAYS OF A TRANSFORMING DEOXYRIBONUCLEIC ACID IN SINGLE- AND DOUBLE-STRANDED FORMS. Njcole Rebeyrotte (Institut du Radium, Paris). Biochim. Biophys. Acta, 76: 234-46(Oct. 15, 1963). (In French)

Transforming DNA from Pneumococcus in its natural state (double stranded) and in a denatured state (single stranded) was irradiated with x rays and uv light. The survival of the genetic marker, resistance to streptomycin, was determined as a function of irradiation dose in three different experimental procedures: denaturation, irradiation, and condensation; denaturation, condensation, and irradiation; and irradiation, denaturation, and condensation. The action of x rays was studied under conditions of indirect effect (dilute aqueous solution) and semi-direct effect (sample frozen in 1% yeast extract). The results obtained in each case are compared and discussed. In particular, the focus rests on their significance in regard to the biologically active structure of the selected marker and the respective mode of action of x rays and uv light on this structure. (auth)

5025 THE RELATIONSHIP BETWEEN GENE-CONTROLLED RADIATION RESISTANCE AND FILAMENT FORMATION IN ESCHERICHIA COLI. P. van de Putte, Carla Westenbroek, and A. Roersch (National Defence Research Organization, TNO, Rijswijk, Netherlands). Biochim. Biophys. Acta, 76: 247-56(Oct. 15, 1963).

By conjugation experiments the position of the genetic determinant fil on the chromosome of Escherichia coli strain B was determined. This fil marker, which affects the radiation resistance of the strain, is most probably located between the markers controlling galactose fermentation and tryptophan synthesis. The radiation-resistant mutant E. coli B fil^- differs from the wild-type E. coli B fil^+ in its colony-forming ability and morphology after ultraviolet irradiation or incubation in a medium with an appropriate concentration of crystal violet or radioactive phosphorus; cells of the wild type grow in long filaments whereas cells of the resistant mutant do not. This filament formation in the wild-type strain is strongly reduced when the cells are incubated in medium with pantoyl-lactone. Under this condition the survival of the wild-type strain fil^+ equals that of the radiation-resistant mutant. Besides its effect on the filament formation in E. coli pantoyl-lactone influences the lysis induced in Bacillus subtilis by uv irradiation or treatment with crystal violet. The probable relationship between uv-induced lysis in the Gram-positive B. subtilis and the uv-induced filament formation in the Gram-negative E. coli is discussed. (auth)

5026 CATALASE AND IONIZING RADIATIONS. J. Cheymol, M. Adolphe, and F. Heitz (Faculté de Médecine, Paris). Bull. Acad. Natl. Med. (Paris), 146: 582-6 (Oct. 1962). (In French)

Catalase used was a crystalline calf liver product with a specific activity of 22 U/mg. Purity was much greater than preparations previously used. A study of the toxicity of this catalase given intravenously in adult mice, showed it to be very low, of the order of 500,000 U/kg for LD_{50}; 400,000 U killed 20/100 mice; 250,000 U 16/100; and 100,000 U 0/100. Its radioprotective property was assessed by determining the mortality after an LD_{100} x-ray dose in test animals receiving catalase. Two-month-old male mice were utilized which presented a positive weight-gain curve, and which had been kept under the strictest sterile conditions of habitat and nutrition, and whose drinking water had had terramycin added to it a week prior to irradiation. Daily intraperitoneal injections of terramycin were also given for six days. These conditions were considered to be essential for reproducibility of results. The radiation consisted of 800 r delivered as 250-kvp x rays, at a rate of 50 r/min. A 500 U/20 g injection of lyophilized dissolved catalase was given intraperitoneally just before use in physiologic saline or pH 7 phosphate buffer. The elapsed time between the injection and irradiation was 10 min, 30 min, or 3 days. The 3-day period corresponded to the maximum hypouricemic and hypocholesterolemic response to catalase observed in guinea pigs. These two metabolic responses, presumably related to the regulation by catalase of peroxide formation, were thought to express its peak activity. The results showed that catalase had no radioprotective activity for mammals in toto. In three out of seven experiments there was only a slight increase in survival time for the injected mice. (BBB)

5027 OCCURRENCE OF 2C (G_1) AND 4C (G_2) NUCLEI IN THE RADICLE MERISTEMS OF DRY SEEDS IN TRITICUM DURUM DESF. ITS IMPLICATIONS IN STUDIES ON CHROMOSOME BREAKAGE AND ON DEVELOPMENTAL PROCESSES. Silvana Avanzi, A. Brunori, F. D'Amato, Vittoria Nuti Ronchi, and G. T. Scarascia Mugnozza (CNEN, Rome and Università, Pisa, Italy). Caryologia, 16: 553-8 (May-Aug. 1963).

Results are reported from a study of the relative radiosensitivity of two varieties of wheat (Triticum durum). Data are included from an investigation of the amount of DNA in individual cell nuclei, chromosome breakage by x rays in dry seeds, and labeling experiments in dry irradiated seed using H^3-thymidine as a label. (C.H.)

5028 THE EFFECT OF REPEATED SMALL DOSES OF RADIOACTIVE BETA-RADIATION ON THE SURVIVAL OF SKIN HOMO-GRAFTS. J. Vrubel and B. Vavrejn (Inst. of Clinical and Experimental Surgery, Prague). Casopis Lekaru Ceskych, 102: 1272-3(1963).

The survival of skin homo- and autografts on rabbits ears after local effect of small doses of radioactive beta radiation was studied. Doses were 60, 120, and 180 rep, respectively within 6 days. It was found that the period of survival of homografts became shorter with the increasing doses of radiation, while the autografts showed no macroscopic changes. (OTS)

5029 CYTOGENETIC STUDIES FOLLOWING HIGH DOSAGE PATERNAL IRRADIATION IN THE MEALY BUG PLANOCOCCUS CITRI. I. CYTOLOGY OF X_1 EMBRYOS. H. Sharat Chandra (Univ. of California, Berkeley). Chromosoma, 14: 310-29(June 1963).

In cultures of the mealy bug, following high dosage paternal Co^{60} γ irradiation (60000–120000 rep), the survivors are mostly female (an increase of 30 to 40% above the unirradiated control value) whereas very few males survive (about 5% of control value). After lower doses of paternal irradiation (PI), however, few or no females survive while the normal number of males survive. The females developing after high dosage PI are gynogenetic and

are triploid or diploid, or 3N/2N or 2N/N mosaics. The cytology of X_1 embryos following 90000 rep is described and compared with that of embryos following lower doses (8000 r) of PI and unirradiated controls, to illustrate the chromosomal mechanisms leading to the production of gynogenetic females and the probable reasons for lethality of X_1 males after heavy PI. It was shown that triploid females stem from a fusion nucleus of the first and second polar bodies. This triploid polar nucleus, which normally participates in the formation of a polyploid sector in the young embryo, undertakes successful embryogeny in many embryos when the zygote nucleus is unable to do so because of the heavily damaged paternal complement of chromosomes. Since the chromosomes are characterized by holokinetic activity, the irradiated paternal set manages to divide with the maternal complement but does not always segregate as successfully. Restitution divisions of the zygotic nuclei result in haploid, hyperhaploid, diploid, and polyploid nuclei. Most of the diploid gynogenetic females probably originate from diploid nuclei of zygotic origin, although it is possible that a few diploid females and the 2N/N mosaic females develop from polar bodies. (BBB)

5030 CYTOGENETIC STUDIES FOLLOWING HIGH DOSAGE PATERNAL IRRADIATION IN THE MEALY BUG PLANOCOCCUS CITRI. II. CYTOLOGY OF X_1 FEMALES AND THE PROBLEM OF LECANOID SEX DETERMINATION. H. Sharat Chandra (Univ. of California, Berkeley). Chromosoma, 14: 330-46(June 1963).

Females of the mealy bug were mated to males previously irradiated with heavy doses of Co^{60} γ rays (30000 to 120000 rep), the progeny is mostly female. Observations are made on diploid, triploid and mosaic survivors. These X_1 females are gynogenetic, with unbroken chromosomes. Detailed cytology of 17 such gynogenetic females showed triploids, diploids, 3N/2N and 2N/N mosaics. Most of the embryos produced by triploid mothers were aneuploid and these degenerated before gastrulation. Regardless of aneuploidy, male embryos showed the typical lecanoid heterochromatization of the paternal set of chromosomes. Just prior to degeneration, the euchromatic chromosomes in the aneuploid male embryos showed endomitotic splitting while the heterochromatic did not. Among the progeny of triploid female and diploid male matings, only males with five euchromatic plus five heterochromatic chromosomes and females with 10 or 15 euchromatic chromosomes were found. A search for adults with 5 heterochromatic + 10 euchromatic chromosomes among the progeny of triploid mothers was unsuccessful. Chromosomal variables such as aneuploidy of the euchromatic set, haploidy and fragmentation are discussed in relation to the problems of heterochromatization of the paternal set and sex determination of this species. (BBB)

5031 HYPERTENSION AND ISCHEMIC HEART DISEASE IN HIROSHIMA, JAPAN. Sam Switzer (Atomic Bomb Casualty Commission, Hiroshima-Nagasaki). Circulation, 28: 368-80(Sept. 1963).

A random sampling of Hiroshima residents, comprising 1,051 males and 1,872 females, was studied with respect to the interrelations of hypertension, ischemic heart disease, blood lipid levels, and ionizing irradiation experienced during the atom bombing of 1945. No significant effect of ionizing radiation upon the cardiovascular system was detected. No major difference in age-sex specific mean blood pressures between Hiroshima residents and a suitable white American comparison group was found. Japanese exhibit low serum cholesterol concentrations by Western standards and elevated levels are predominantly limited to the obese. Both factors appear of importance in the occasional hypertensive Japanese with ischemic heart disease. The therapeutic implication of this observation is briefly discussed. (auth)

5032 ACTION OF X RAYS ON THE TUMORAL PROPERTIES OF TISSUE OF TOBACCO CROWN-GALL. Maria Ivone Duarte. Compt. Rend., 257: 3034-5(Nov. 13, 1963). (In French)

The tissue of a stem of tobacco crown gall irradiated by x rays is still capable of producing tumors if it is grafted onto an entire plant, even if the inactivation is complete enough to inhibit almost completely its power to grow in vitro. (tr-auth)

5033 EFFECTS OF X IRRADIATION ON THE OXYGEN CONSUMPTION AND GLYCOLYSIS IN AEROBIOSIS OF EMBRYONIC ORGANS OF CHICKENS IN ORGANOTYPIC CULTURES. Jean-Michel Kirrmann and Georges Le Douarin (Collège de France, Paris and CNRS, Paris). Compt. Rend., 257: 3235-8(Nov. 18, 1963). (In French)

X irradiation provokes a precocious inhibition of the oxygen consumption in embryonic intestines and hearts of chickens in organotypic cultures. The oxygen consumption returns to its normal value in the culture after about 30 to 50 hr. Glycolysis in aerobiosis, fully established after 150 hr in culture, shows no difference for irradiated and control samples. (tr-auth)

5034 THE INCREASE OF BILIRUBINEMIA FOLLOWING THE IRRADIATION OF THE RAT WITH X RAYS. Jean Loiseleur and Michelle Petit (Institut Pasteur, Service de Chimie-Physique, Paris). Compt. Rend. Soc. Biol., 157: 1164-5(1963). (In French)

The variation of bilirubin concentration after whole-body x irradiation of the rat was studied. Male albino rats were exposed to doses of 500 to 950 r. In the nonirradiated animal bilirubin has a mean concentration of 0.91 mg/l. This concentration increases in the irradiated animal as a function of the dose administered. After a lethal irradiation, bilirubin increased 245% in several hours. (J.S.R.)

5035 STUDY OF DELAYED MORTALITY, LYMPHOID REGENERATION, AND IMMUNOLOGICAL REACTIVITY OF IRRADIATED THYMOPRIVIC MICE RESTORED BY FETAL LIVER, BONE MARROW, OR ISOGENIC SPLEEN. J. F. Duplan and P. Monnot (Institut du Radium, Paris). Compt. Rend. Soc. Biol., 157: 1211-16(1963). (In French)

The effects of fetal liver, medullary, or splenic cells on the lymphoid restoration and the recovery of the immunological functions in irradiated thymoprivic adult mice were compared. Male and female mice were subjected to a thymectomy or a simulated thymectomy at the age of 35 to 40 days. These mice, together with a control group, were then exposed at the age of 60 to 75 days to whole-body x irradiation of 870 r. Each group was then subdivided into three groups: one group received an intravenous injection of fetal liver, bone marrow, or splenic cells. The study of the mortality showed that during the 30-day period following the irradiation, the immediate mortality was the same in all the animals. The thymoprivic mice treated with fetal liver had a particular behavior. They had characteristic secondary illnesses, although the restoration was isogenic. The lymphoid regeneration, in particular that of the small lymphosytes, was deficient. Sixty days after the irradiation, there was no evidence of active immunological cells in the spleen of the mice receiving fetal liver. This can be attributed to

the fact that the fetal liver contains a very small number of mature lymphoid cells and the immature cells can not attain, in the absence of the thymus, a stage of their evolution that permits the normal functions of lymphoid cells to be fulfilled. (J.S.R.)

5036 CONSUMPTION OF OXYGEN IN THE RAT EXPOSED TO LETHAL X IRRADIATION: ABSENCE OF SIGNIFICANT RESPONSE TO THE ADMINISTRATION OF THYROXINE AND TRIIODOTHYRONINE. M. Lemaire and J. Closon. Compt. Rend. Soc. Biol., 157: 1304-10(1963). (In French)

A comparative study was made of the oxygen consumption in the normal and whole-body-irradiated rat treated with thyroxine and triiodothyronine. The experimental methods and results are discussed in detail. It was shown that the oxygen consumption of the irradiated rat was not significantly modified five days after the irradiation. Thyroxine and triiodothyronine do not induce a statistically significant response in the irradiated animals. The intervention of cortisone as a peripheral inhibitor of this response can be retained. (J.S.R.)

5037 EFFECT OF X RAYS ON METACERCARIA IN FASCIOLA HEPATICA. E. Lagrange (Institut Royal des Sciences Naturelles, Brussels). Compt. Rend. Soc. Biol., 157: 1310-11(1963). (In French)

Metacercaria of Fasciola hepatica were exposed to various doses of soft x rays and then injected subcutaneously or ingested by mice. Doses of 500, 1000, and 3000 r do not prevent the cysts from killing the mice within the normal time. Half the mice receiving cysts exposed to 4000 r survive, but if these mice received cysts exposed to 2000 r 6 weeks later, all of the mice were killed. Metacercaria exposed to 5000 r do not kill the mice, but the mice received no immunity to subsequent administration of Fasciola hepatica. (J.S.R.)

5038 EFFECT OF X RADIATION ON THE PHENOMENON OF "WATER SENSITIVITY" IN BARLEY. C. Gillet (Euratom, Liege). Compt. Rend. Soc. Biol., 157: 1323-6(1963). (In French)

Seeds of Hordeum sativum Jess., a spring barley, were exposed to various x-ray doses. The seeds had a water concentration of 10.5% at the moment of irradiation. One batch of seeds was placed in germination immediately after irradiation, but the second batch was held over for 24 hrs before germination. Both batches were germinated in the presence of an excess of water. The results showed that the germination is stimulated by sufficiently high irradiation doses. The 24-hr storage modifies the germinating power of the grain. The inactivation of the –SH group of a germination inhibitor and the modifications of the O_2 pressure in the grains seem to be the two most important factors in the germination of irradiated "water-sensitive" barley. (J.S.R.)

5039 THE EFFECT OF IONIZING RADIATIONS ON ONTOGENESIS IN BIRDS. Mircea Dinu. Comun. Acad. Rep. Populare Romine, 13: 891-900(1963).

The effect of strong doses of ionizing radiations on the ontogenetic development of birds and formation of mutations was studied. The data obtained show that ionizing radiations have a different effect on the biological substratum, depending on their nature and relationship to physiological limits. Gamma radiations have a negative action on the biochemical process altering the substratum and upsetting the entity of heredity. It was found that x rays produce a temporary stimulating effect on metabolic processes influencing the vitality, ontogenetic development, resistance, the appearance of sexual instinct, and the fertility. Ionizing radiations affect functioning of endocrinic glands and consequently the ratio of sexes in the offspring. From the results obtained it can be stated that strong doses of ionizing radiations may be used to obtain variation of mutations, and that in general they are a factor in the evolution of the living organism. (OTS)

5040 ASYNAPSIS IN PEPPER FOLLOWING X IRRADIATION OF THE POLLEN. D. T. Morgan, Jr. (Univ. of Maryland, College Park). Cytologia (Tokyo), 28: 102-7 (Mar. 1963).

Failure of normal first division association of homologous chromosomes was observed in two pepper plants during cytological studies on the causes of sterility in the first generation following x irradiation of the pollen. Other than asynapsis, no chromosomal abnormality was evident in either plant. Irradiation of the pollen induced genotypic alterations affecting the capacity of like chromosomes to remain associated through metaphase I in X_1 microsporocytes. A description is given of meiosis in the two sterile plants, which differed primarily in the degree of asynapsis. Two autodiploid lines of pepper were used as female parents and crossed with x-rayed pollen of the variety Floral Gem. Autodiploid G168A, developed from a haploid of the variety Goliath, was crossed with pollen exposed to 500 r. An asynaptic plant, designated V9, occurred among 11 male sterile individuals in the X_1. The other asynaptic XX24 plant was detected among 105 male sterile plants from crosses of autodiploid P1A, derived from a haploid of Perfection Pimento, with pollen of Floral Gem irradiated at 2000 r. The pollen was irradiated at a rate of 170 r/min with a unit operated at 100 kvp, and at a target distance of 30 cm with 0.25 mm of aluminum filtration. The microspores produced by both plants were highly irregular. Micronuclei were evident in many of the spores, and the occurrence of small, supernumerary spores was frequent. Pairs of large spores were found infrequently in both plants. No mitotic irregularities were observed in longitudinal and cross sections of root-tips. In XX24, metaphase I was characterized by varying numbers of scattered univalents, ordinarily remotely located from the clumped bivalents on the metaphase plate; and two homologous chromosomes, comprising a bivalent at diakinesis and metaphase I, were associated terminally in the partially asynaptic cells. The average number of univalents per cell for the 30 asynaptic microsporocytes of XX24 was 12.5. With the exception of a single cell having four bivalents and the remainder of the complement disassociated, the metaphase I configurations of V9 were characteristically clumped, so that a precise analysis of the numbers of bivalents and univalents was not possible. However, 1 to 16 univalents, ordinarily widely separated from the clumped chromosomes on the metaphase plates, were detected in 74% of the metaphase I configurations examined; an average of 5.7 univalents occurred in the cells showing asynapsis. Lagging chromosomes and unequal distribution of dyads were evident at anaphase I and telophase I in both plants. Because of the tangled nature of the pachytene and earlier prophase I stages, comparison of the frequency of failure of pairing during early prophase I with the frequency of univalents at metaphase I could not be made, and it was not possible to determine whether the univalents detected at diakinesis and metaphase I were the result of initial failure of synapsis or desynapsis following pairing of homologous chromosomes. (BBB)

5041 THE RELATIVE RADIOSENSITIVITY OF THE GENETIC STRUCTURE OF MAMMALIAN CELLS IN

VITRO. L. I. Lebedeva, T. D. Osetrova, and Yu. Yu. Kerkis (Inst. of Cytology and Genetics, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 152: 1225-6(Oct. 11, 1963). (In Russian)

The overall sensitivity of a mammal to radiation is expressed by a $DL_{50/30}$ value, which is 300 to 400 r for the guinea pig (a little less than the $LD_{50/30}$ value for man), and is 550 r for the CC57 BR line of mice. Fresh cultures of fibroblasts of 1 to 1.5 month embryos of the guinea pig, and of 15 to 17 day embryos of the mice were fixed 36 hours after irradiation with a dose of 10 or 50 r, and the number of chromosomal rearrangements in anaphase and telophase was determined. Analysis of the data showed that the more radioresistant the animal, the smaller was the percent of chromosomal rearrangements per 1 g of tissue, which was 0.303 for the guinea pig at a 10 r dose, 0.157 for the guinea pig at a 50 r dose, and 0.072 for the mice at a 50 r dose. The corresponding figures are 0.156 for man, 0.053 for the rabbit, and 0.027 for the hamster. (TTT)

5042 NEW TYPES OF CHROMOSOMAL REARRANGEMENTS OCCURRING IN MICROSPORES OF TRADESCANTIA PALUDOSA UNDER THE INFLUENCE OF A NUMBER OF FACTORS IN OPERATION DURING THE FLIGHT OF A SPACE SHIP. N. L. Delone, P. R. Popovich, V. V. Antipov, and V. G. Vysotskii. Dokl. Akad. Nauk SSSR, 152: 1227-30(Oct. 11, 1963). (In Russian)

Special spherical fragments were found in material fixed during an orbital flight. The spherical fragments appear to be micronuclei, but they cannot be micronuclei, since they occurred in the course of a single mitosis. The ratio of the number of spherical fragments to the total number of chromosomal and chromatid fragments during metaphase was 1.77 on Vostok-3, and 1.81 on Vostok-4. This ratio was 2.0 and 1.74, respectively during telophase. A new type of chromosomal arrangement involved the formation of complex bridges with the appearance of a single spherical fragment. The ratio of complex exchanges to dicentrics, and to chromosomal and chromatid exchanges during metaphase was 0.34 on Vostok-3, and 0.35 on Vostok-4. An acceleration of 5000 g causes the formation of spherical fragments during interphase and prophase, or of particular chromosomal and chromatid fragments that are almost spherical in nature (during metaphase, anaphase, and telophase). Because of the similarity observed in the chromosomal rearrangements, it was concluded that acceleration is the cause of the occurrence of the new type of chromosomal rearrangement. (TTT)

5043 THE NUCLEUS OF THE CANCER CELL: EFFECTS OF IONIZING RADIATION. Arthur C. Upton (Oak Ridge National Lab., Tenn.). Exptl. Cell Res., Suppl., 9: 538-58(1963).

An increasing variety of effects must be considered in attempting to explain the action of ionizing radiation in the induction and cure of cancer. The most important effects appear to involve primarily the nucleus of the cell, although knowledge of nucleo-cytoplasmic relationships may eventually indicate otherwise. The great majority of mammalian cells, neoplastic and normal, have a mean lethal x-ray dose of less than 150 r if judged by interference with their capacity for sustained proliferation. Furthermore, the survival kinetics in such cells suggest that killing by x rays involves a multi-stage injury process, part of which is reparable. Since the radiosensitivity and survival kinetics of certain nondividing cells are similar to those of dividing cells, one cannot implicate exclusively mutations or effects on DNA synthesis, chromosome duplication, and mitosis in radioinduced cell killing. Such effects, nevertheless, occur in response to small amounts of radiation and may be presumed to play an important role in the response of cells surviving other injuries. It is not yet possible to define the mechanisms of radioinduced cell death, and it is likely that they vary in importance from one type of cell to another. Furthermore, direct effects of radiation on cancer cells in vivo are complicated by the interaction of irradiated cells with one another and with the host. Growing knowledge of factors influencing cellular injury and repair encourages hope for increasingly selective and favorable modification of the radiation response of neoplastic and host cells, with resulting gains in radiotherapy. (133 references.) (auth)

5044 INFLUENCE OF AN IRRADIATED AND NON-IRRADIATED HOST ON THE DEVELOPMENT OF POST-IRRADIATION CHANGES IN BONE MARROW CULTIVATED IN VIVO. Blažena Koukalová (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 9: 382-7(1963).

The effects of humoral factors in the organism on radiation injury of bone marrow cultivated in vivo was studied. Changes in the mitotic index and in the metaphase-prophase quotient were observed. In cultivation of non-irradiated bone marrow in irradiated hosts, the latter (650 r) were found to have a short-term inhibitory effect on the values of the indicators. Bone marrow from irradiated donors was cultivated in irradiated and non-irradiated hosts. The beneficial influence of the non-irradiated hosts on the course of post-irradiation changes in the implanted bone marrow was not very marked. (P.C.H.)

5045 THERMOSTABILITY OF COLLAGEN FIBRES AFTER X-RAY IRRADIATION IN VITRO. Jaromíra Dvořáková and M. Pospíšil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 9: 396-7(1963).

Investigations were made on the possibility of breaking down collagen after x irradiation in vitro. The method consisted in studying the solubility of collagen fibers from the tendons of the rat tail during thermic relaxation. The results showed a clear correlation between the solubility of the collagen and the age of the rats. The correlation was not affected by irradiation. In every case, however, the irradiated specimens were significantly more soluble than the control fibers of the same age. (P.C.H.)

5046 GENOTYPE X ENVIRONMENT INTERACTION WITH ISOGENIC LINES OF DROSOPHILA MELANOGASTER. J. F. Kidwell (Brown Univ., Providence). Genetics, 48: 1593-1604(Dec. 1963).

Two experiments which exploit some of the peculiar genetic properties of Drosophila melanogaster were conducted to study the nature of the interaction of genotype × environment. All possible crosses were made among four isogenic lines, each representing a different mass mated stock. A sample of virgin females from each line, line cross, and original mass mated stock was irradiated (6000 r or 4000 r) at about 48 hr of age. A similar non-irradiated sample was also measured. The traits measured were number of eggs and live larvae produced by days 4, 6, and 8, and the number of adults eclosing from eggs deposited on days 9, 10, and 11. The analysis provides a comparison of three breeding types, and estimates of inbreeding depression, heterosis, general and specific combining ability, maternal and reciprocal effects and their interaction with treatment. Significant effects were

observed for treatments, breeding types, mass mated stocks and isogenic lines in both experiments. Differences in general combining ability were found for egg and larva number but not for number of adults in both experiments. Large interactions of treatment × breeding type, treatment × mass mated stock, and treatment × isogenic line were observed for all traits at 6000 r, whereas at 4,000 r only two of these interactions were significant. (C.H.)

5047 RADIATION INDUCED X-Y EXCHANGE AND NONDISJUNCTION IN SPERMATOCYTES OF THE IMMATURE TESTIS OF DROSOPHILA. S. Zimmering and C. K. Wu (Brown Univ., Providence). Genetics, 48: 1619-23 (Dec. 1963).

The x irradiation response of primary spermatocytes of the immature testis of Drosophila melanogaster was investigated employing a genetic scheme which made possible an immediately classifiable distinction in the offspring between nondisjunction of X and Y, and exchange between X and Y in the treated male. (C.H.)

5048 THE EFFECT OF ULTRAVIOLET LIGHT ON RECOMBINATION IN YEAST. D. Wilkie and D. Lewis (University Coll., London). Genetics, 48: 1701-16(Dec. 1963).

Spontaneous and uv-induced somatic recombination was studied in four strains of yeast heterozygous for four to ten genes, both linked and unlinked. The frequency and distribution of simultaneous recombinant homozygotes indicate that pairing and crossing over occur between all homologous chromosomes in those cells where the event is taking place. In the case of linked genes, a negative correlation between the frequency of homozygosis and map distance from the centromere was found. A mechanism of meiotic crossing over and segregation followed by nondisjunction or restitution at the second division is postulated to explain these results. In support of this, it was found that cells grown on sporulating medium produced a higher proportion of homozygous diploids than did cells in the stationary phase or in log phase in a growth medium. The frequency of homozygosis of individual genes on different chromosomes shows no correlation with centromere linkage, a result which would be expected on the basis of crossing over at the two-strand stage with meiotic segregation and nondisjunction at the second division. The mechanism of uv induction is discussed in terms of a change from a mitotic to a meiotic condition in cells which respond to irradiation. (auth)

5049 CYTOGENETIC AND SUBMOLECULAR BIOLOGICAL STUDIES ON THE EFFECT OF X RAYS ON METABOLISM OF DEOXYRIBONUCLEIC ACID (DNA) OF EHRLICH'S ASCITES CARCINOMA CELL NUCLEI. Tetsuji Kadotani (Hiroshima Univ.). Hiroshima J. Med. Sci., 4: 117-36(Dec. 1962).

Effects of x rays on incorporation of P^{32} into DNA of the tumor cells were studied. The carcinoma was implanted in the abdominal cavity of mice, and on the 7th day after implantation, single whole-body 200- or 500-r doses of irradiation were given. Immediately after irradiation, 1 μC P^{32}/g body weight was injected into the abdominal cavity. Mice were then killed at hourly intervals to collect ascitic fluid. Protein was removed to obtain DNA from tumor cell nuclei. In the unirradiated controls, P^{32} uptake in DNA took place relatively rapidly until 12 hours after P^{32} injection but thereafter the rate showed an almost constant value. X irradiation was inhibited division of tumor cells and destroyed many cells. During this period, DNA as a thread-like sediment in ascitic fluid could not be obtained. However, after 9 hours when the effect of x irradiation on tumor cells decreased, the frequency of appearance of abnormal cells decreased and the frequency of mitosis of tumor cells increased, the thread-like DNA sediment could be obtained. Moreover, P^{32} uptake in DNA showed a parallel relation to the frequency of mitosis. It is shown that DNA synthesis in Ehrlich's ascites carcinoma cell nuclei is performed prior to mitosis, and that irradiation inhibits this DNA synthesis and causes degeneration of DNA molecules. No conclusive results were achieved in the nucleotide chromatography experiments. (BBB)

5050 STUDY OF EPIDEMIOLOGICAL FACTORS AFFECTING THE FREQUENCY OF OCCURRENCE OF CONGENITAL ANOMALIES. Akira Tabuchi, Michinori Ishibashi, Kazuo Kinutani, Tsuyoshi Hirai, Toshiharu Shintani, Shigeru Nakagama, Masumi Horikawa, Mitsuki Sanada, and Akira Mitani (Hiroshima Univ.). Hiroshima J. Med. Sci., 4: 143-58(Dec. 1962).

Children born (after the 8th month of pregnancy) of mothers hospitalized for delivery from January 1961 through September 1962 at Hiroshima University affiliated hospitals were investigated. Among 153 children with congenital anomalies, there was a relatively large number (27) with more than two anomalies. A study of the effect of consanguinity between parents, blood type compatibility of the parents, atomic bomb exposure of mothers or fathers, abdominal x-ray exposure of mothers, and age of mothers showed no significant difference between children with congenital anomalies and the control children. However, primiparous women over 30 yr of age showed a somewhat higher birth rate of prematures, and the sex ratio of children born of women over 30 yr of age (whether they are primiparous or multiparous) tended to be high. It is concluded that, as epidemiological factors affecting the frequency of birth of children with external deformity, the following should be considered as important: hormone administration, drug therapy, and x irradiation before the 3rd month of pregnancy. (BBB)

5051 RADIATION DAMAGE TO THE BRAIN—A NEW SYNDROME. W. D. Rider (Ontario Cancer Inst., Toronto). J. Can. Assoc. Radiologists, 14: 67-9(June 1963).

Three cases of postirradiation brain damage considered to be a new clinical and pathological entity are described. Three women were irradiated for tumors in and around the left middle ear. Treatment plans and isodose distributions show that a maximum tissue dose of about 5500 rad of Co^{60} γ radiation was delivered to each patient. The treatment time was ~1 month, but the fractionation was different. In the first case there were 20, the second 27, and the third 16 fractions. The clinical course was similar. Clinical examination showed gross cerebellar ataxia, horizontal nystagmus, and Romberg's sign. In the first case there was also paralysis of the 6th cranial nerve and an extensor plantar response. The first patient died four weeks after the onset of symptoms, while the other two started to show signs of recovery after four weeks, made a complete recovery in about 6-8 weeks, and are alive and well six years later. An autopsy on the first patient showed disseminated demyelination in a patchy fashion. Plaques were found in the white matter of the cerebrum, cerebellum, and brain stem, where the dose was highest, but there were lesions on the opposite side also where the dose was much lower. There was only a minor degree of blood vessel change, and it was of an early kind, unlike the more commonly seen fibrinoid necrosis of arterial walls. Secondly, passing through the areas of demyelination were normal neurons

and axons. Around the plaques, astrocytic proliferation and clasmatodendrosis were seen, and around this a wall of microglial cells. It was considered that radiation might have invoked an allergic or autoimmune response. In view of the very marked similarity, it is not unreasonable to assume that all 3 patients had similar pathological processes and that some, as yet unknown, factor permitted two to live and allowed one to die. The points of difference from previously defined syndrome are as follows: the latent period between radiation and onset is measured in weeks instead of months; the onset is acute instead of gradual; recovery may take place; the pathological picture is of demyelination rather than blood vessel damage. The possibility that damage to myelin sheaths or cytoplasmic enzyme systems is involved is discussed. (BBB)

5052 EFFECT OF X-RAY EXPOSURE ON THE EUROPEAN CORN BORER. John R. Walker (Louisiana State Univ., Baton Rouge) and Tom A. Brindley. J. Econ. Entomol., 56: 522-5(Aug. 1963).

Adult male (0- to 24-hr-old) Ostrinia nubilalis moths were irradiated with 250-kv x rays at a dose rate of 500 r/min and placed in cages with untreated females. Daily records were kept of mortality, egg production, and egg hatch. When untreated virgin females were mated with irradiated males, the percentage of viable eggs decreased with an increase in the dose. The average egg hatch in the untreated controls was 80.4%, whereas matings with male moths exposed to 10000, 20000, and 30000 r showed averages of 37.7, 9.9, and 0.1% egg hatch, respectively. In matings of males exposed to 4000, 8000, 16000, and 32000 r, the average percentages of viable eggs were 58.1, 44.5, 16.4, and 0.4, respectively. An increase in the ratio of irradiated males to untreated males and females resulted in reduction of the percent of viable eggs. A ratio of eight irradiated males to four untreated males to eight untreated females resulted in 39.4% egg hatch, as compared with 62.7% in untreated controls and 1.1% in irradiated controls. When pupae 48 to 78 hr old were irradiated and later mated to untreated adults, the percent of egg hatch was reduced by increasing doses. The percent hatch was 69.9 when the male pupae were exposed to 2500 r, and when the dose was increased to 7000 r, only 49.9%. At all doses tested the percentage of egg hatch was greater from matings containing treated females. Matings of male pupae exposed to 5000 r resulted in 63.8% hatch, but the same dose applied to female pupae resulted in only 15.8%. Adults from younger pupae produced eggs that generally showed a lower percentage hatch than older pupae after exposure to x rays. Matings of females exposed as pupae produced fewer viable eggs than those with males treated as pupae, regardless of pupal age at irradiation. When the percentage of egg hatch was plotted semilogarithmically against dose, the resultant dosage-response curve was initially linear with an increased gradient at the higher doses. Dosage-response curves indicate that the corn borer is more resistant to the effects of radiation than other insects. Irradiated male corn borers survived about as long as untreated males (~7 days). It is concluded that adult male corn borers can be sterilized by doses of 32000 r or above and that at this dose 1% or less of the eggs will hatch from matings with untreated females. (BBB)

5053 THE EFFECT OF X-RAY IRRADIATION ON MELANOCYTES IN THE SKIN. R. S. Snell (Univ. of Durham, Newcastle-upon-Tyne, Eng.). J. Invest. Dermatol., 40: 233-41(May 1963).

X-ray effects on melanocytes and melanin in the skin of the anterior abdominal wall were studied in black and in red male guinea pigs, at doses too low to cause erythema and other inflammatory responses. The 50-kv x rays were administered to give a surface dose of 500 rad in 0.07 min, in three sessions at weekly intervals. Biopsy skin specimens were removed 12 to 19 days following the last session. Irradiation resulted in a considerable increase in the amount of melanin present, both inside and outside melanocytes. This was accomplished by an enlargement of the pigment cell size and an increase in the length, width, and complexity of its dendritic processes. There was also a marked increase in melanocyte numbers. The increased melanogenesis was slightly less in skin specimens removed 19 days after the last irradiation, compared with those removed 12 days after treatment. Vertical sections of skin showed a considerable rise in the amount of melanin present in all layers of epidermis. An occasional flattened pigment-containing high-level branched cell was seen and large numbers of dermal melanophores packed with melanin granules were noted postirradiation. The rise in melanocyte count could be explained on the basis that mitotic division had taken place, or it is possible that amelanotic dopa-negative melanocytes are normally present in all the basal layer of the epidermis and were stimulated into activity by the x rays. In some guinea pigs, no melanocytes were seen in the control specimen, but after irradiation large numbers were present. Increased intracellular melanin suggests an increased cytocrine activity of the melanocytes following x rays. It is also suggested that following irradiation the upward movement of the melanocytes to the surface from the basal layer, which is their natural fate, is so rapid that they have insufficient time to discharge all their melanin and are thus found high up in the epidermis. (BBB)

5054 THE RECEPTOR HYPOTHESIS OF INDUCTION OF GENE-CONTROLLED ADAPTIVE ENZYMES. Carl C. Lindegren (Southern Illinois Univ., Carbondale). J. Theoret. Biol., 5: 192-210(Sept. 1963).

An alternative hypothesis of gene action, developed from the study of gene-controlled α-glucosidases in yeasts, is outlined. The receptor-hypothesis model of gene-controlled adaptive enzyme induction is discussed with reference to experimental data on the melezitose locus (MZ^{TMSGZ}) in Saccharomyces, controlling the induction of the adaptive enzyme, melezitose, which acts on five substrates: turanose, maltose, sucrose, methyl-α-D-glucopyranoside, and melezitose. The tmsgz recessive allele was refractory to regeneration by any of these five substrates and failed to produce fermenter type offspring on any medium containing these substrates. When cells bearing the recessive gene tmsgz were treated with x rays, and subsequently plated on melezitose, the completely regenerated gene was produced. When cells of tmsgz cultures (which do not mutate back to TMSGZ on melezitose-agar) were x irradiated and then plated on melezitose, a small proportion (10^{-8}) of the survivors formed melezitose-fermenter colonies. Thus, x rays have the capacity to increase the plasticity of the gene and to facilitate and reinforce the mutagenic action of the post-irradiation substrate. The phenomenon shows that genic material highly refractory to remodeling can be effectively altered if x rays and substrate act on it jointly. The x-ray dose-response curve for induction of TMSGZ back-mutants is linear, indicating that the mutation from tmsgz to TMSGZ involves an alteration in the genetic material that effectively restores all 5 traits by a one-hit event. The failure to detect partially recessive allelic mutants among x-irradiated tmsgz cells plated on turanose,

maltose, sucrose, and methyl-α-D-glucopyranoside supports the conclusion that the mutation from recessiveness to dominance is a one-step event. (BBB)

5055 EFFECTS OF ROENTGEN RAYS ON ANAPHYLACTIC SHOCK IN GUINEA PIGS. Bela Csaba, Tibor Szilagyi, Maria Kavai, Imre Szatai, and Ferenc Toth (Orvostudomanyi Egyetem, Korelettani Intezet, Debrecen, Hungary). Kiserl. Orvostud., 13: 274-81 (June 1961). (In Hungarian)

Experiments were conducted on 200- to 500-g male guinea pigs, one group of which received 200-r, whole-body, 180-kv x irradiation at 14.3 r/min and were sensitized with 5 mg crystaline ovalbumin seven days post-irradiation. Anaphylaxis was induced with 4 mg ovalbumin 21–5 days after sensitization. A second group received fractional irradiation of 10 r daily to a total of 200 r, and then was sensitized as in the first group. In addition, passive sensitization experiments were conducted on isolated guinea pig ileum suspended in vitro in Tyrode's solution, and the Schultz-Dale reaction was elicited with ovalbumin. Results showed that guinea pigs which were not irradiated died 3–4 min after challenging injection in acute anaphylactic shock, whereas 50% of the acutely irradiated animals survived, although in a few instances a severe reaction was noted. The fractionally irradiated animals which were sensitized by one antigen injection showed a 60% mortality rate and severe shock symptoms in the survivors. Only 30% of the twice-injected animals in the second group survived and they also showed severe shock symptoms. The passively sensitized (with rabbit anti-ovalbumin) animals received 200-r total irradiation and shock was brought about 48 hr later. It was found that irradiation did not prevent death, nor did it influence the Schultz-Dale reaction in isolated ileum of passively sensitized animals. Irradiation of rabbit immune serum in vitro did not inactivate the specific reactive groups of the antibodies. Studies on irradiated immune serums showed that their ability to precipitate with antigen was not impaired. (BBB)

5056 BRAIN STUDY OF MICE EXPOSED TO COSMIC RAYS IN THE STRATOSPHERE AND REPORT OF NUCLEAR EMULSION MONITORING IN FOUR BALLOON FLIGHTS FROM BEMIDJI, MINNESOTA JULY–AUGUST 1960. Herman Yagoda, Albert Behar, Richard L. Davis, Keith L. Kraner, Robert Filz, John Hewitt, and Webb Haymaker (Air Force Cambridge Research Labs., Bedford, Mass.). Military Med., 128: 655-72(July 1963).

A study was undertaken to determine whether the brains of mice flown in the stratosphere are damaged by cosmic rays. The flights carried nuclear emulsions that served as directional monitors for heavy primaries penetrating the brains, and an histological study was made of those parts of the brain penetrated by the heavier primary particles. The four flights carrying the mice were at altitudes between 40,200 and 43,800 m (130,000 and 140,000 ft) for 10 to 12 hours. In the monitoring emulsions, star-production on each of the flights varied between 1581 and 2111/cm^3/day. The energy of the average star-producing particle was ~560 Mev. The production rate of proton enders varied from 498 to 604/cm^3/hr, indicating the absence of a solar flare of appreciable intensity. The heavy primary thin-down frequency for particles $Z \geq 6$ averaged 7.9/cm^3/day. Each of the 36 brains examined received an average of ~7 hits, about ⅓ of which were by particles having a charge $Z \geq 16$, and the remainder $Z = 12 \pm 3$ (energies of these particles were not ascertained, but probably lie between 10^9 and 10^{18} ev). The animals were sacrificed over periods of 3 to 66 days postflight. No evidence of damage attributable to cosmic rays was found, although ~1000 sections of each brain were examined histologically. (BBB)

5057 RADIATION-INDUCED BONE TUMORS AFTER THORIUM-X TREATMENT. H. Spiess, H. Poppe, and H. Schoen (Universität, Göttingen, Ger.). Monatsschr. Kinderheilk., 110: 198-201(Mar. 1962). (In German)

Fifty three patients treated with 2500 to 14000 units of Th–X during childhood showed injuries to the long bones. Of another group of 53 patients who had been treated with Th–X, 19 have either died or suffer from induced bone tumors. Almost all of the tumors are osteogenic sarcomas localized in the region of the metaphyses of the long bones. Some have been observed in the pelvis, ribs, and diaphyses of the long bones, but osteogenic sarcomas are seldom observed in the ankle or wrist bones. Occurrence of a second osteogenic sarcoma in the same patient after a period of time is probably not the result of a metastasis, but is more likely a second primary sarcoma. In each of four patients who had previously received Th–X treatment an unusual number of osteogenic sarcomas induced by radiation have been detected. (BBB)

5058 STUDIES ON THE EFFECT OF ^{60}Co GAMMA IRRADIATION ON THE GOAT. II. LETHAL EFFECT OF ^{60}Co GAMMA IRRADIATION ON THE GOAT. Mitsuaki Hayashi and Noboru Miyao. Natl. Inst. Animal Health Quart., 3: 156-65(1963).

Goats were examined for survival time and changes in erythrocyte and leukocyte counts and hematocrit value after a single or repeated irradiations with Co^{60} γ rays of 100 to 1,000 r. The survival time was 5 to 12 days for animals irradiated with 700 and 1,000 r, 20 and 25 days for two of three animals with 400 r, and over 30 days for an animal with 400 r and ones with below 200 r. Goats irradiated with 100 to 400 r required considerable cumulative doses for lethality. Transient high values of erythrocyte count were often observed immediately after exposure or during the survival time. A decrease in erythrocyte count was observed in the case of repeated small-dose radiation. Leukopenia began to appear 24 to 48 hr after exposure. Diarrhea always occurred to animals irradiated with 1,000 r, but not to those irradiated with below 700 r. The body weight decreased in animals irradiated with large doses. It increased slightly or remained at the initial level in those exposed to small doses. (auth)

5059 A MECHANISM FOR THE DIRECT ACTION OF IONIZING RADIATIONS. Reinier Braams (Rijksuniversiteit, Utrecht). Nature, 200: 752-4(Nov. 23, 1963).

A model is proposed for the mechanism of radiation effects on proteins. Some of the features are: real protection is possible through a mechanism of radical scavenging, similar to the mechanism now widely accepted for protection against the indirect affect. The protection is limited to a factor 2–3 in agreement with experimental observations, both on proteins and on bacteriophage. A simple chemical mechanism is given to explain the apparent interaction between the protein radical and the protective substance. (P.C.H.)

5060 EFFECT OF X-IRRADIATION ON SUSCEPTIBILITY OF CELLS TO TRANSFORMATION BY POLYOMA VIRUS. Michael Stoker (Univ. of Glasgow). Nature, 200: 756-8(Nov. 23, 1963).

An investigation was made on the effects of x rays on the sensitivity of BHK21 cells to transformation by polyoma virus. The x-ray sensitivity of uninfected BHK21 cells was first determined. To investigate the effect of irra-

diation on subsequent polyoma transformation, batches of 1-2 million BHK21 cells were exposed in suspension to various doses of irradiation. Equal numbers of cells (about one million) from each batch were infected in suspension with 10^8 plaque-forming units of polyoma virus and assayed for transformation by the standard method. It was found that the irradiation reduced the number of viable cells giving normal colonies more rapidly than the number giving transformed colonies. After 500 r and subsequent infection the proportion of normal viable cells had fallen from 46 to 4.4% whereas the transformed viable cells only fell from 2.5 to 0.87%. The difference led to an increase in the transformed colony frequency. It was concluded that prior irradiation of BHK21 cells followed by polyoma virus infection increases the probability that the survivors will yield transformed clones. (P.C.H.)

5061 MOLECULAR LESIONS PRODUCED IN RIBONUCLEASE BY GAMMA-RAYS. J. F. Williams and J. W. Hunt (Univ. of Toronto and Ontario Cancer Inst., Toronto). Nature, 200: 779-81(Nov. 23, 1963).

Experiments on the effects of gamma radiation on ribonuclease suggested that structural changes such as the breakage of certain disulfide bonds and molecular conformity changes are produced so that latent tyrosyl groups become easily ionizable. (P.C.H.)

5062 X-IRRADIATION OF DEOXYRIBONUCLEIC ACID. Shan-ching Sung and J. H. Quastel (McGill-Montreal General Hospital Research Inst., Montreal). Nature, 200: 781-2(Nov. 23, 1963).

A loss of ability of Ehrlich ascites carcinoma cells to take up irradiated DNA and an increased susceptibility of DNA to DNase after x irradiation is reported. When C^{14}-DNA was x irradiated with 500 rads for 5 min no uptake was observed. When heated DNA was used instead of native DNA the uptake was reduced. The uptake was also reduced after treatment of DNA with pancreatic DNase (8 μg/ml). However, when DNA was irradiated in the presence of 1 mM cysteine, the activity taken up by ascites cells was almost undiminished. (P.C.H.)

5063 DETERMINATION OF RADIATION-INDUCED MUTATION RATES OF RECESSIVE LETHAL ALLELES IN SACCHAROMYCES. W. Laskowski and K. Haefner (Freie Universität, Berlin). Nature, 200: 795-6(Nov. 23, 1963).

An attempt to determine radioinduced mutation rates of specific genes to recessive lethal alleles was undertaken by comparing the survival rates of irradiated diploid cells heterozygous for one recessive lethal allele ($S_{+/l}$) with those of diploid cells homozygous for the corresponding vital alleles ($S_{+/+}$). Two out of three investigated +/l strains did show a significantly increased x-ray sensitivity as compared with the values obtained for the parental +/+ strain. Mutation rates of 0.15 and 0.25 were calculated. The occurrence of extremely high mutation rates to recessive lethal alleles in Saccharomyces was thus confirmed. (P.C.H.)

5064 CHANGES IN THE ESTERASES OF RAT BRAIN AND BLOOD SERUM FOLLOWING ACUTE CRANIAL EXPOSURE TO X-RAYS. E. B. Masurovsky and C. R. Noback (Columbia Univ., New York). Nature, 200: 847-9(Nov. 30, 1963).

Clear cut differences in the protein and esterase patterns were shown in the irradiated and control halves of rat brains. The changes induced by acute doses of x radiation in the esterases of brain cells and blood serum after cranial exposure appeared, on the basis of the differences in electrophoretic migration and substrate-inhibitor activity, to be largely indigenous to the respective systems. The most profound changes occurred in blood. Several of the esterase components of the blood serum zymogram patterns were decidedly inactivated by irradiation while the brain tissue zymogram patterns exhibited an apparent increase, or a decrease in the activity of certain esterolytic proteins. It was concluded that these divergencies in the zymogram patterns may not only represent additions or deletions of enzymatically active molecules from the various cellular elements comprising the brain tissue, but also certain ancillary changes in their structural configurations and charge distributions as well. (C.H.)

5065 TRANSMISSION OF ULTRA-VIOLET RAYS IN QUARTZ FIBRES. J. Baskerville Hyde (Meharry Medical Coll., Nashville). Nature, 200: 906(Nov. 30, 1963).

An apparatus is described for use in studies of the biological effects of ultraviolet radiation in the brain. Ultraviolet photons are conducted to the deeper cells of the brain with quartz fibers that act as conductors. The preparation and properties of the quartz fibers are discussed. (C.H.)

5066 MULTIPLE ANOMALIES OCCURRING IN A NEW-BORN SPANISH GOAT FOLLOWING PRENATAL GAMMA-RADIATION. C. A. O'Brien, E. W. Hupp, J. W. Austin, M. Szabuniewicz, and A. M. Sorensen, Jr. (A. and M. Coll. of Texas, College Station). Nature, 200: 906-7 (Nov. 30, 1963).

A number of morphological defects are described that were observed in a single new-born goat following prenatal exposure of the mother on the 30th day of pregnancy to 300 r Co^{60} γ radiation. (C.H.)

5067 A RED EYE COLOUR MUTATION IN CULEX PIPIENS AFTER X-IRRADIATION. A. Wild (Johannes Gutenberg-Universität, Mainz). Nature, 200: 917-18 (Nov. 30, 1963).

Four 1- to 2-day-old males of Culex pipiens were irradiated with a dose of 4,000 r x radiation. A mutant red eye was isolated from F_3 cultures of two of the irradiated males. Further crossing indicated that the factor for red eyes was sex-linked. (C.H.)

5068 THE EFFECT OF X RADIATION ON THE ACTIVITY OF 5-HYDROXYTRYPTOPHAN DECARBOXYLASE. H. Langendorff and U. Hagen (Universität, Freiburg i. B.). Naturwissenschaften, 50: 665(1963). (In German)

The carboxylation of 5-hydroxytryptophan (HT) in irradiated animals was determined using the Huang method for the anaerobic incubation of tissue homogenates with HT as substrate. Significant enzyme activities were found only in the liver of the inbred mice used. The distribution of the decarboxylase in the liver cells is tabulated. The total activity of the ferment is localized almost exclusively in the cytoplasm. If the activity of the enzyme in the liver is measured at various times after whole-body irradiation with 690 r, there is a decrease of the activity after the seventh day. The addition of pyridoxal-5-phosphate leads to lower reactivation of the enzyme. (J.S.R.)

5069 THE EFFECT OF 5-HYDROXYTRYPTAMINE (SEROTONIN) ON THE RADIATION-INDUCED MUTATION RATE IN E. COLI. H. A. Kuenkel and A. Trams (Universität, Hamburg). Naturwissenschaften, 50: 666(1963). (In German)

The protective effects of serotonin against radioinduced mutations were investigated in E. coli. Suspensions of E. coli were exposed to total doses of 40,000 r at a dose output of 800 r/min. Ten minutes before the irradiation, suf-

ficient amounts of serotonin were added to give a 0.01 M solution. Determination of the effects of serotonin on the radioinduced inactivation rate showed that there was a significant radiation-protective effect of this compound. The survival rate increased from 6.5 to 17.7%. Serotonin decreased the mutation rate from $9800/10^8$ surviving to $5400/10^8$ surviving. (J.S.R.)

5070 THE EFFECT OF IONIZING RADIATION ON THE BONE MARROW. H. Fleischhacker and A. Stacher (Hanusch-Krankenhauses, Vienna). Nucl. Hematol., 2: xi-xiv(Dec. 1963-Feb. 1964). (In German)

A chronic radiation injury to an assistant in a Radium Institute gave an occasion to discuss the problem of radiation effects on bone marrow. After a description of the course of sickness, which, after 23 years of radiation effects, went from panmyelophthisis to myeloblast leukemia, some new viewpoints on radiation effects were examined. After a discussion of the biochemical principles, the radiation-conditioned reactions of the cells in the tissue culture were emphasized. Complex changes in the regulation mechanism between cells and nerves were studied. The originating mechanism of myeloblast leukemia in relation to radiation injury is discussed. (tr-auth)

5071 BONE MARROW REGENERATION IN IRRADIATED-BLED MICE STUDIED BY THYMIDINE-H^3. D. Rašković, S. Hajduković, and J. Karanović (Inst. of Nuclear Sciences "Boris Kidrich," Belgrade). Nucl. Hematol., 2: xv-xvi(Dec. 1963-Feb. 1964).

Preliminary data concerning the effect of post-radiation bleeding anemia (erythropoietine) in organisms exposed to ionizing radiation are presented. The effect of bleeding, immediately after mice were sublethaly irradiated, on the proliferative activity of bone marrow cells was investigated. Bone marrow activity was estimated by incorporation of tritiated thymidine. The labeled compound enters DNA only in cells preparing for division. About 50% of bone marrow cells of normal, untreated mice are labeled. When mice were only irradiated, the level of incorporation varied, depending on the time at which observations were made after irradiation. In animals sacrificed after 24 hr, this value was low. On the 10th day, the number of labeled cells reached the same level as in untreated animals. But on the 15th day, incorporation again decreased. In bone marrow cells from mice irradiated and bled, the level of incorporation also varied with time. Twenty-four hours after treatment incoporation was low (9%). However, on the 10th day this value reached the same level as in untreated animals, and on the 15th day the same value was maintained. (M.C.G.)

5072 STUDY OF THE CUTANEOUS REACTIONS INDUCED BY BETA-EMITTING RADIONUCLIDES. F. Pigorini and O. Trucchi (Università, Rome). Nuntius Radiol., 29: 456-75(June 1963). (In Italian)

With reference to previous research carried out by means of electrons accelerated by a betatron, the cutaneous changes induced by beta radiations emitted by most commonly used radionuclides, such as P^{32} and $Sr^{90} + Y^{90}$, were analyzed. The sources of P^{32} employed consisted both of preparations realized on blotting paper and in activated plastic materials. The latter appeared more suitable for research because the radionuclide is more uniformly distributed. Observations showed that the smallest dose capable of provoking a early short-lasting erythema is about 1000 rad; the threshold of reaction (smallest dose sufficient to determine a reaction) is 400 to 800 rad and the pigmentation reaches at its maximum 15 to 40 days after the irradiation. With doses of 800 to 1000 rad, no trace of skin changes was observed in most cases after three months. The threshold of desquamation, which usually appears after 30 to 40 days, is about 2000 rad. For high doses (up to 20,000 rad for a 0.7 cm^2 field and up to 18,000 rad for larger fields) no epidermolysis (humid reaction) was observed. At about 10,000 rad, a superficial white area may be observed, limitedly to the central portion of the irradiated field, which appears after nearly 3 months and is delimited by an halo of hyperpigmentation. No remarkable difference between the skin reactions produced by the radiations of both radionuclides, was noted. Comparative observations were carried out with 6-Mev electrons accelerated and with 55-kev x rays. The ratio between beta radiations of the considered radionuclides and the accelerated electrons was about 1 : 2 for the main wave of the erythema. By increasing the administered dose, the cutaneous tolerance for the beta radiation increased. The dry epidermitis recovered more rapidly with very high doses. In comparison with the x rays, not only a much higher tolerance for the radiations of the radionuclides, but also the absence of the third growth of the erythema was observed, which with x rays habitually appears about the 35th day. The differences in the behavior of the cutaneous reaction provoked by the beta rays of the radionuclides are to be attributed partly to the difference in dose distribution in depth, and partly to the different relative biological effectiveness. This factor is important only in relation to the comparisons with the x rays. (auth)

5073 OVARIAN HILUS CELLS AND ENDOMETRIAL CARCINOMA WITH REFERENCE TO RADIATION. Stanley Ames and N. A. Janovski (Columbia Univ., New York). Obstet. Gynecol., 22: 67-72(July 1963).

A survey of the relation of hilus cell genesis and frequency of detection in ovaries to adenocarcinoma of the endometrium is presented. Results were based on the examination of 281 ovaries obtained from patients with endometrial carcinoma. The results showed that there was no statistical difference between the occurrence of hilus cells in the endometrial carcinoma group and a control group (33 and 25% respectively). However, if mode of treatment was taken into consideration, and patients undergoing irradiation for endometrial adenocarcinoma prior to operation separated into an individual group, there was a significant difference in the distribution of hilus cells in those patients as compared with the non-irradiated carcinoma group, at the level of 5%. The radiotherapy in these cases consisisted mainly of 50-100 mg intracavitary Ra for ~72 hr. A surprisingly high incidence (60%) of ovarian hilus cells was found in patients who underwent radioinduced menopause for benign gynecologic conditions prior to developing adenocarcinoma of the endometrium. The incidence in all postmenopausal patients was only 37%. Ovarian hilus cells were more prevalent in postmenopausal women irrespective of endometrial carcinoma. Premenopausal women with endometrial carcinoma who received no irradiation prior to definitive operation are, therefore, the ideal subjects for further investigation of the relation between endometrial adenocarcinoma and ovarian hilus cells. (BBB)

5074 BONE SARCOMA: REPORT OF AN INTERESTING CASE. J. Bloom, S. Oliver, and K. H. Thoma (Boston Univ.). Oral Surg., Oral Med., Oral Pathol., 14: 981-8 (Aug. 1961).

The case of a 51-yr-old woman who received radiotherapy following discovery of of an ossifying fibroma of the jaw associated with Paget's disease is described. Irradia-

tion consisted of 1440 r to each side of the mandible, given in six treatments. Nine years later a fibrosarcoma was removed from the irradiated jaw. The tumor was characterized by a marked anaplasia, pleomorphism, and numerous tumor giant cells. Shortly after surgical removal the patient died. It is concluded that the evidence favors the probability that the patient suffered originally from Paget's disease, which was subsequently complicated by sarcoma of bone, however, the concomitant existence of Paget's disease and fibrous dysplasia is also considered as the initial diagnosis. The relation of the terminal sarcoma to the radiation received by the patient is obscured by the fact that Paget's disease is known to be complicated by sarcoma in an estimated 10% of the cases. Nevertheless, the amount of radiation given to the patient was thought to be sufficient to induce sarcoma. The interval of nine years between the x-ray treatments and the appearance of the tumor is consistent with the previously estimated latent period. Although it is unlikely that in this case the diagnosis can be properly considered to be other than Paget's disease complicated by sarcoma, it is possible that, as additional information concerning the relation of irradiation to malignancies of the jaws becomes available, the events recorded in this report may be subject to reinterpretation as radioinduced sarcoma. (BBB)

5075 OSTEOCHONDROMATA FOLLOWING IRRADIATION IN CHILDREN. A. R. C. Gole and J. M. M. Darte (Hospital for Sick Children, Toronto). Pediatrics, 32: 285-8(Aug. 1963).

During the past three years, development of osteochondromata was observed within the area of irradiation in eight children treated by surgical and irradiation therapy. Although the occurrence of malignant change in bone following irradiation is well known, development of benign tumors of bone, such as reported here, is not well documented. Seven of the reported cases occurred following radiation treatment for neuroblastoma and nephroblastoma. A summary of the cases is presented with respect to radiation dose and field area, latent period, and survival time. The records show 153 cases of neuroblastoma and nephroblastoma, 67 of which are living. Sixty-two living patients received irradiation with or without operation and seven (10%) of these living irradiated patients show osteochondromata. None of the few surviving children treated by operation developed osteochondromata. The patients were three years of age or less when treated, a period when bone is growing rapidly and may be more sensitive to irradiation. From the cases reviewed and the literature it is evident that the age at which the patient is irradiated is important for tumorigenesis. The total absorbed tumor dose was estimated to vary from 1050 to 2850 rad, given over 13 to 29 days and a field of 10 × 20 cm. It is suggested that use of megavoltage sources may decrease the incidence of these tumors by decreasing the differential in absorption by bone and soft tissue. The latent period ranged from 17 months to 9 years 3 months. An exostosis is the result of disturbance of enchondral ossification and it is suggested that irradiation in these children initiated this disturbance. Reasons for removal of osteochondromata are cited. In only one case was the osteochondroma removed, because of the possibility of its being a bony metastatic lesion. Patients with such tumors should be carefully followed because of the possibility of malignant change in the lesion. (BBB)

5076 THYMIC IRRADIATION: CARCINOMA FOLLOWS INFANT THERAPY. Paul M. James, Jr., Millard N. Croll, John M. Howard, and William Kashatus (Hahnemann Medical Coll., Philadelphia). Penn. Med. J., 66: 28-30(July 1963).

Induction of carcinomas after thymic irradiation is reviewed, and another instance of thyroid carcinoma occurring in an adolescent patient with a history of radiotherapy during infancy is recorded. A 16-year-old girl was admitted to hospital for evaluation of a right cervical mass in 1960. This mass had been present and enlarging for at least three months, cervical adenopathy on the right side had been noted three years prior to admission. There were no mechanical or metabolic symptoms referrable to the thyroid at the time of admission. Review of her medical history revealed thymic irradiation for stridor and an enlarged thymus in the first year of life, and later irradiation of the neck for adenitis at age five (the amount of irradiation is unknown). At surgery an adenocarcinoma of the thyroid gland was revealed by frozen section, and lymph nodes were found to contain metastatic carcinoma. Histologic appearance of the tumor is described. The final histologic diagnosis was papillary adenocarcinoma of the right lobe of the thyroid, with metastasis to six lymph nodes of the neck and anterior mediastinum. The patient was followed for 36 months and apparently remains free of recurrent cancer. (BBB)

5077 CHANGES IN THE PERMEABILITY OF CARROT TISSUES DUE TO γ IRRADIATION AND OTHER PHYSICAL AND CHEMICAL TREATMENTS. J. P. Skou (Danish Atomic Energy Commission, Riso, Roskilde, Denmark). Physiol. Plantarum, 16: 423-41(1963).

The effect of Co^{60} radiation on the permeability of carrot tissue and the possibility of reducing this effect by means of $CaCl_2$ were studied. In addition, the radiation effect was compared to the effects of freezing and treatment with various fixing fluids. Carrots of the Nantes variety were used, and γ irradiation was carried out at 4°C with doses varying from 35 to 1450 krad. The loss of sugar and ions in water and the uptake of sucrose from solution were shown to increase strongly with increasing doses. The weight loss in molar sucrose plus the weight loss in water, as compared to untreated samples, were reduced considerably with increasing doses of radiation. In the presence of 0.01M $CaCl_2$ the uptake of sucrose was considerably lower and the weight loss was considerably higher in molar sucrose, but the overall course of the curves was the same as in the absence of $CaCl_2$. Gains and losses of matter proceeded exponentially with increasing doses. The weight loss in sucrose was accompanied at low doses by shrinking and plasmolysis of the cells. At higher doses there was no such reaction. In addition, it was shown that the rates of uptake and release of matter were dependent on temperature and on the area of cut surface/volume ratio, while the final result was independent of these values. The extent of exudation through the periderm was very slight at low (< 250 krad) doses. It was also shown that Ca induced rigidity of the cell walls and reduced the permeability of cells to sucrose. Na had a reverse effect. Low pH values (~2) caused a direct loss of matter from the cells to water. It was not possible to demonstrate any certain effect of oxalate ions (0.01M) on the uptake of water. Freezing of the tissue gave the same curves as the highest dose of radiation used, but the effects on its structure were different. Fixing fluids had the reverse effect of irradiation on permeability. Respiration experiments showed the respiration to decrease simultaneously with a marked increase in permeability. It is concluded that the combination of the radioinduced injuries to the tissues (impairment of the wound

healing, deterioration of cell walls, and increased permeability) provide saprophytes with the same growth possibilities afforded the parasites on untreated carrots, and that treatment with low concentrations of $CaCl_2$ reduce the deleterious effects of radiation. (BBB)

5078 GRAFT-HOST RESPONSE IN MURINE RADIATION CHIMERAS. Edwin M. Uyeki (General Electric Co., Richland, Wash.). Proc. Soc. Exptl. Biol. Med., 114: 554-9(Dec. 1963). (HW-SA-3133)

After lethal whole-body x irradiation, host mice received bone marrow from normal donors as well as from donors pretreated with host tissue. The results indicated a higher percentage of survivors in the latter case. To aid in interpretation of those results, a xenogenic chimera (rat → mouse) was assessed for the state of erythrocyte chimerism body weight, hematocrit values and serum antibody titers. The results are in agreement with the idea that the surviving chimeras were immunologically reactive, since both host- and graft-type hemagglutinins were found in their sera 3 to 4 weeks following treatment. Generally, subnormal hematocrit and body weight values coincided with the emergence of antibody titers. (auth)

5079 RADIATION DAMAGE AND RECOVERY IN DIPLOID AND CYTOCHIMERAL VARIETIES OF APPLES. Charlotte Pratt (N. Y. State Agricultural Experiment Station, Geneva). Radiation Botany, 3: 193-206(Sept. 1963).

Radiation damage and recovery of diploid and cytochimeral varieties of apple and the chromosomal constitution of recovered shoots of irradiated cytochimeras were studied. Dormant scions were exposed to 3000 r of x rays or 3 hr of thermal neutrons (average flux 6.57×10^8 neutrons/cm^2/sec) and grafted. As soon as the irradiated buds of Northern Spy (2x) and Loop Spy (2-2-4-4) began to grow, the central cells below the first layer of apical and axillary meristems were conspicuous by their failure to stain normally. Such radiation-damaged cells did not divide. The cells lateral and basal to them hypertrophied and divided. Shoot growth, when it occurred, was resumed in one or more of three ways: the damaged cells of the apical meristem were crushed by the growth of adjacent cells and the healed meristem resumed growth; the cells lateral to the damaged apical meristem formed a substitute meristem; or axillary meristems, many of them healed, developed at one or more nodes below the apical meristem. More shoots recovered in the diploid varieties, Northern Spy and McIntosh, than in their chimeral sports, Loop Spy and Kimball McIntosh. The chromosomal constitution of recovered shoots depended upon the ploidy of the cells taking part in recovery and their subsequent intrasomatic selection. Two types of changes in chromosomal constitution were found in cytochimeral shoots examined one to five years after irradiation. The determination of chromosomal type was based on the distribution of diploid and tetraploid tissue in growing buds, and on pollen size and fruit shape wherever possible. The types are described by a formula indicating the ploidy (2x or 4x) of the uppermost four layers of the meristem. One change was the increase in tetraploid (inner) tissue in Loop Spy and Welday Jonathan (2-2-4-4 to 2-4-4-4 or 4x). No such increase was observed in Kimball McIntosh (2-4-4-4) or Bates Lobo (2-2-2-4). Increase in diploid (outer) tissue was found more frequently than increase in tetraploid (inner) tissue. The latter occurred more frequently in long shoots than in short shoots from irradiated buds of Loop Spy. Increase in diploid tissue was found often in Loop Spy and Welday Jonathan (2-2-4-4 to 2-2-2-4, 2-2-2-2-4 or 2x) and rarely in Kimball McIntosh (2-4-4-4 to 2-2-4-4 and 2-2-2-4). (auth)

5080 MICRONUCLEI IN IRRADIATED MERISTEMS. F. A. L. Clowes (Oxford Univ.). Radiation Botany, 3: 223-9(Sept. 1963).

The percentages of cells with micronuclei counted at intervals after acute x irradiation of the root meristems of Zea mays show two peaks. These two peaks occur clearly only after heavy doses (900 and 1800 rads) and only when restricted regions of the root tip are considered, not when squashes of whole tips are used. The first peak, which occurs at four days after irradiation at 1800 rads, is probably due to those cells that were in G_2 at the time of irradiation coming into their first post-irradiation mitosis. The second peak, which occurs at eight days after 1800 rads, is probably due to those cells that were in G_1 at irradiation being delayed more severely than the other cells in coming into mitosis. The dip between the two peaks can be accounted for on the assumption that the cells in G_2 at irradiation undergo second and subsequent mitoses before the G_1 cells undergo their first division thus lowering the percentage of cells with micronuclei. The temporal positions and the relative heights of the maxima are discussed in relation to the dose and the lengths of the mitotic cycle in the various regions of the meristem. The quiescent center of the meristem is less sensitive to x rays than the other regions at all dose levels and in it mitosis is stimulated by irradiation. (auth)

5081 PREDICTED AND OBSERVED EFFECTS OF CHRONIC GAMMA RADIATION ON A NEAR-CLIMAX FOREST ECOSYSTEM. G. M. Woodwell and A. H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 3: 231-7(Sept. 1963). (BNL-6968)

Shoot growth and tree mortality were measured for the six principal woody species of a forest ecosystem which was being subjected to chronic gamma radiation from a Cs^{137} source. These responses were compared with responses predicted on the basis of nuclear volume and chromosome number alone, a technique described in an earlier publication. Observed growth was generally less than predicted for any exposure, suggesting a general mechanism affecting the prediction. Two factors are suggested as potentially important: the higher physiological stresses characteristic of natural ecosystems and the fact that woody species seem generally more sensitive to ionizing radiation than herbaceous species of similar chromosome number and nuclear volume. It is clear from this work that prediction of the range of sensitivity of plants in natural arrays is possible now within broad limits from chromosome number and nuclear volume alone, but further refinements of the method are needed. (auth)

5082 GROWTH INHIBITION, MITOTIC CYCLE TIME AND CELL NUMBER IN CHRONICALLY IRRADIATED ROOT MERISTEMS OF PISUM. J. Van't Hof and A. H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 3: 239-47(Sept. 1963). (BNL-6943)

Seedlings of Pisum sativum were chronically irradiated with gamma rays from a Co^{60} source at daily exposure rates sufficient to produce growth inhibition. Exposure rates of 500 and 1000 r/day reduced root growth by the fourth day. In order to determine the factor(s) that might be responsible for the reduced growth rate, the following measurements were made: the number of cells comprising the root meristem was determined daily for seven days; the percentage of aberrant cells at anaphase was scored after three days exposure; and the minimum mitotic cycle time for meristematic cells was established, also after three days of exposure. Cell counts showed an approximate reduction of 5, 25, and 45% compared to control on the third

day of exposure at rates of 250, 500, and 1000 r per day. The minimum mitotic cycle time was measured by producing a tetraploid cell population with colchicine and noting the span of time between the production of this population and its initial appearance in the subsequent mitosis. These measurements indicated no change in the minimum cycle time of the cells in the irradiated meristems as compared to the unirradiated controls. Analysis of cells at anaphase showed an increase in the number of cells with broken chromosomes with increased exposure rate. Therefore, the reduction in growth observed in irradiated seedlings was attributed to the loss of reproductive integrity not due to a general slowing down of the cells' division rate but rather to genetic loss and/or unbalance and mitotic arrest of meristematic cells. (auth)

5083 EFFECT OF ROENTGEN RAYS ON THE DIATOME NITZSCHIA LINEARIS. H. Hellwig (Technische Universität, Berlin). Radiation Botany, 3: 249-57(Sept. 1963). (In German)

The influence of x rays on the diatom Nitzschia linearis was studied. Experiments gave a multi-hit dose-response curve with an extrapolation number 1 over 100. The study of single cell division after irradiation showed that with low doses several divisions occurred, before the mechanism of cell division came to a halt. With high doses only one further division is possible. By dose fractionation a considerable increase in survival and characteristic shift in dose-response curve can be obtained. Radioinduced secondary effects from without the cell can not be found. Owing to the high extrapolation number, a formal explanation by means of the target theory is avoided; however, a reasonable explanation can be derived if two different mechanisms of inactivation are supposed. (auth)

5084 EFFECTS OF RADIATION ON THE PHOTOPERIODISM OF PORTULACA SMALLII. David J. Cotter (Alabama Coll., Montevallo). Radiation Botany, 3: 265-9 (Sept. 1963).

Flats of Portulaca smallii were exposed in a Co^{60}-field to six radiation treatments: 1000, 5000, 15,000 (at three dose rates), and 30,000 r. These plants and controls were exposed to two photoperiods: a natural photoperiod of 14 hr which favored vegetative growth or a 10-hr photoperiod which approximates maximum floral induction. Increased radiation was found to suppress both vegetative and reproductive potentials, and that reproduction was more sensitive to radiation than growth. Differences in photoperiod responses remained evident but were less marked as dosage increased. 30,000 r was found to exceed the LD_{50} dose. (auth)

5085 AN ANALYSIS OF GROAT-WEIGHT VARIATION IN IRRADIATION-DERIVED POPULATIONS OF OATS. S. Okabe, K. J. Frey, and S. Taniguchi (Iowa Agricultural and Home Economics Experiment Station, Ames). Radiation Botany, 3: 271-81(Sept. 1963).

Primary and secondary caryopses (groats) of oat lines derived from irradiated and nonirradiated Clintland and Beedee varieties were subjected to component analysis according to the formula; groat weight = $L\,(W/2)^2\,\pi DS$, where L and W represent groat length and width, and π, D, and S are the constants, 3.14, density, and shape. In the Clintland-derived materials, the mean weights of both groat classes (primary and secondary) were significantly greater in the irradiation-derived population than in the controls. Although the means of each component in the irradiation-derived materials were slightly higher than their counterparts in the control populations, only width of the primary groats was significantly increased. The greater groat length and width in the irradiation-derived population accounted for the total increase in primary groat weight, but for only a portion of the increase in secondary groat weight. Correlated variation of secondary groat length and width was responsible for secondary groat weight being greater than expected. The genetic correlations between groat length and width were +0.14 and +0.73 for primary and secondary groats, respectively. In the Beedee-derived materials, the mean groat weights of the irradiation-derived and check populations were not significantly different, but the mean groat widths were significantly decreased, and the mean groat lengths were significantly increased. The changes in length and width tended to nullify the effects of one another when contributing to groat weight. The actual groat weights were smaller than expected for both primary and secondary groats. This resulted from the negative associations between groat length and width covariation. The genetic correlations between groat length and width were −0.56 and −0.29 for primary and secondary groats, respectively. (auth)

5086 EFFECT OF UV ON THE DIATOME NITZSCHIA LINEARIS. P. Braetter (Technische Universität, Berlin). Radiation Botany, 3: 287-95(Sept. 1963). (In German)

In the diatom Nitzschia linearis a method was developed that permits radiobiological investigations and gives reproducible results. The dose-response curve and the dose-depending formation of micro- and macro-clones for uv irradiation (254 nm) were studied. It could be shown that inactivation is partly photoreactivable (maximal reactivation between 400 and 500 nm, constant DRF of 0.55). After uv irradiation typical morphological changes were observed. The radiobiological results in Nitzschia linearis are compared with data for other microorganisms. (auth)

5087 RESTORATION OF AGGLUTININ PRODUCTION AGAINST SHIGELLA PARADYSENTERIAE IN IRRADIATED RATS. Warren J. Russell and Waren Litsky (Univ. of Massachusetts, Amherst and Univ. of Vermont, Burlington). Radiation Res., 20: 541-8(Dec. 1963).

The agglutinin response to a standardized heat-inactivated bacterin of Shigella paradysenteriae is relatively radioresistant when the antigen is administered prior to or a few hours after whole-body Co^{60} γ irradiation with 500 r. Radiosensitivity was found to exist when irradiation preceded antigen injection by more than 5 hr. The three isothiuronium compounds tested, AET, MEG, and GED, demonstrated their ability to protect the antibody-forming mechanism against irradiation with 500 r. The toxicity of these chemicals is such that limitations may be imposed on their routine usage. (auth)

5088 EFFECT OF GAMMA IRRADIATION ON GLUCOSE UTILIZATION, GLUTATHIONE, AND ELECTROLYTE CONTENT OF THE HUMAN ERYTHROCYTE. G. Cividalli (Hebrew Univ. Medical School and Hospital, Jerusalem). Radiation Res., 20: 564-76(Dec. 1963).

Samples of freshly drawn heparinized human blood were irradiated with 10,000 to 40,000 rads from a Co^{60} unit and then incubated at 37°C. Under these conditions a greater loss of K took place from the irradiated erythrocytes than from nonirradiated controls; the loss of K was partly replaced by Na. In the range examined this prolytic effect was found to be proportional to the irradiation dose. Removing the leukocyte fraction before irradiation or suspending the irradiated erythrocytes in nonirradiated plasma had no effect on these phenomena. No increased prolysis could be demonstrated when control erythrocytes

were suspended in irradiated plasma. The excessive loss of K in the irradiated erythrocytes was not accompanied by a significant change in osmotic fragility, glucose utilization, reduced glutathione content, and stability, over that found in corresponding controls. No extra increase in cellular volume and water content of the cells, and no hemolysis, which could be attributed to the irradiation, occurred. Under normal conditions, erythrocytes maintain their cation content by a complicated enzymatic process, for which glucose metabolism furnishes the energy, and in which reduced glutathione is presumed to play a role. Most instances of prolysis studied so far have been the result of a disturbance in this enzymatic process. It appears that the prolysis caused by irradiation is due to a different mechanism, possibly to a damaging effect on the structure of the cell membrane. (auth)

5089 RESPIRATION AND GLYCOLYSIS IN X-IRRADIATED EHRLICH MOUSE ASCITES CARCINOMA CELLS. Elmon L. Coe, Eugene N. Garcia, Kenneth H. Ibsen, and Ralph W. McKee (Univ. of California, Los Angeles). Radiation Res., 20: 586-92(Dec. 1963).

Ehrlich ascites tumor cells exposed in vitro at a concentration of 80 mg dry-weight equivalent per milliliter to 500 to 4000 r showed no significant alterations in glycolytic or oxidative metabolism relative to unirradiated controls. At 8000 r, however, there was some indication of damage to glycolysis. Cells irradiated with 500 to 8000 r all showed an increase in ATP concentration, the increase being greater at the higher levels of radiation. These observations are discussed with relation to the fact that cells irradiated with 2000 to 4000 r no longer kill their hosts, but instead grow briefly and then regress, producing an immunity toward the nonirradiated ascites cell. (auth)

5090 THE EFFECTS OF X-RAYS ON THE PROGRESS OF L-CELLS THROUGH THE CELL CYCLE. S. Mak and J. E. Till (Univ. of Toronto and Ontario Cancer Inst., Toronto). Radiation Res., 20: 600-18(Dec. 1963).

Many of the radiation effects on the mammalian cell cycle described by various workers using different cell systems were demonstrated in a single cell culture strain, the subline L60TM of L-strain mouse cells. These effects are: depression in the rate of progress of cells from the G_1 to the S phase; depression of the rate of DNA synthesis shortly after irradiation; recovery of rate of DNA synthesis at later times; inhibition of progress of cells from S to G_2 (S block); and reversal of the S block. (auth)

5091 RADIATION MORTALITY IN THE MOUSE: MODEL OF THE KINETICS OF INJURY ACCUMULATION. I. PROTRACTED DOSES IN THE 30-DAY LETHAL RANGE. S. Phyllis Stearner and Sylvanus A. Tyler (Argonne National Lab., Ill.). Radiation Res., 20: 619-30(Dec. 1963).

The effect of exposure time on the extent of acute radiation injury was investigated in the LAF_1 mouse. Exposures to Co^{60} γ rays were protracted over single periods ranging from 60 min to 1 day. Doses were in the 30-day lethal range, and most deaths occurred in the 9- to 30-day period. The hematopoietic syndrome was the most prevalent lethal mechanism with which death in this period was associated. Dose effectiveness depended on duration of exposure; there was a constant linear decrease in dose effectiveness with increase in exposure period through 6 hr, but there was relatively little further decrease when doses were protracted over longer periods. A kinematic model is presented that describes the dependence of lethality on length of protraction. The model assumes the independent action of two kinetically different injury processes: a time-dependent (reversible) process regulated by a linear reversal of radiation effects and expressed in groups exposed for periods of 360 min or less; and a time-independent (irreversible) process predominately expressed as mortality in groups exposed for 960- or 1440-min periods. By use of the model, sensitivity differences between various strains and species, as well as between different qualities of radiation, can be normalized. Data reported by several investigators were subjected to this transformation, and the constants of the relation between the transformed variable and exposure time are shown to be approximately the same. (auth)

5092 THE RESPONSE OF TWENTY-SEVEN INBRED STRAINS OF MICE TO DAILY DOSES OF WHOLE-BODY X-IRRADIATION. Thomas H. Roderick (Jackson Lab., Bar Harbor, Me.). Radiation Res., 20: 631-9(Dec. 1963).

At various times throughout a 12-month period, males and females from 27 inbred strains were subjected to daily doses of 100 r of x rays until death. The strains with longer survival times had survival distributions with the mode skewed in the upward direction. The deaths of the short-surviving mice in the longer surviving strains occurred mainly in the months of May through October. The greater within-strain variance and lesser difference between means during the warmer months caused a significant seasonal shift in heritability. Heritability was +0.52 in the cooler months. Males survived 1.6 days longer than females under this dose schedule. Some of the strains studied were found to be considerably more resistant to irradiation than the strains previously studied; the upper limit of resistance of inbred strains was therefore extended. The rank order of survival times of the strains agreed well with published data on single-dose LD_{50}, on life span, and on litter size, suggesting that radiation resistance is a good indicator of general fitness. Conversely, it was concluded that the radiation resistance which could be manifested by a genotype could be estimated by the manifestations of that genotype in other fitness traits. (auth)

5093 EFFECTS OF PRENATAL GAMMA IRRADIATION ON THE GERM CELLS OF THE MALE PIG. B. H. Erickson, R. L. Murphree, and J. F. Andrews (Univ. of Tennessee, Oak Ridge). Radiation Res., 20: 640-8(Dec. 1963).

A description is given of certain features of the normal pattern of porcine prenatal testicular development, and, where possible, germ-cell radiosensitivity is related to these. The first evidence for gonocyte (primitive germ cell) radiosensitivity was noted in testes irradiated at 35 days of gestation, but a marked effect on the gonocyte population was not evidenced until day 50. Germ-cell radiosensitivity continued at the same level throughout the remaining portion of gestation studied (to 90 days). Initiation of pronounced gonocyte sensitivity (day 50) was shown to be correlated with the definitive organization of the sex cord. Comparisons between rat and pig gonocyte radioresponses are drawn, and the possibility of a qualitative difference in their respective germ-cell populations is discussed. (auth)

5094 IRRADIATION OF THE EXTERIORIZED CIRCULATING BLOOD OF RABBITS. I. IRRADIATION PROCEDURE AND DOSIMETRY. Peter Abramoff, Myung Moo Choe, and Peter M. Sanfelippo (Marquette Univ., Milwaukee). Radiation Res., 20: 649-57(Dec. 1963).

A successful technique for irradiation of exclusively the circulating blood and a method of obtaining the absorbed dosage for this system are reported. The advantages and

disadvantages as well as the potential use of this technique are discussed. Application of the technique in rabbits is described. (C.H.)

5095 IRRADIATION OF THE EXTERIORIZED CIRCULATING BLOOD OF RABBITS. II. SERUM PROTEIN CHANGES. Peter Abramoff and Myung Moo Choe (Marquette Univ., Milwaukee). Radiation Res., 20: 658-67 (Dec. 1963).

It is indicated that irradiation of the exteriorized circulating blood of rabbits produces both quantitative and qualitative changes in their serum proteins. The radiation appears to enhance the quantitative changes resulting from the operative procedures. The qualitative changes were noted in the experimental group during the first through the fourth day after irradiation in the form of an additional fraction, 6', in the starch-gel electrophoresis. The relationship between the results of this study and those of whole-body irradiation is discussed. (auth)

5096 ACTIVITY OF KREBS CYCLE DEHYDROGENASE SYSTEMS IN LIVER AND SPLEEN OF RATS AFTER WHOLE-BODY X-IRRADIATION. Evelyn Kivy-Rosenberg, Joseph Cascarano, and Benjamin W. Zweifach (New York Univ., New York). Radiation Res., 20: 668-76(Dec. 1963).

By the use of a tetrazolium salt, INT, the dehydrogenase system activity of homogenates of liver and spleen was measured microchemically in three portions of the Krebs cycle: malate-dependent, succinate-dependent, and isocitrate-dependent. Young adult CFN male rats were used, and liver and spleen homogenates were assayed at specific periods after irradiation. Liver was found to be more sensitive than spleen to whole-body x irradiation. Both organs showed a fall in activity as early as 5 to 10 min postirradiation. (auth)

5097 THE CELLULAR BASIS OF DIFFERENTIAL RADIOSENSITIVITY OF NORMAL AND GENETICALLY ANEMIC MICE. Elizabeth S. Russell, S. E. Bernstein, Eleanor C. McFarland, and W. R. Modeen (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Radiation Res., 20: 677-94(Dec. 1963).

The hematological reactions of radioresistant normal ww mice and of extremely radiosensitive WW^v mice were followed during a 30-day period after 200 r of whole-body irradiation. Although the normal mice showed only minor changes in the peripheral erythrocyte level, the anemic mice suffered prolonged extreme reduction in hematocrit level, persisting through at least 16 days after irradiation. Reticulocytes disappeared completely from the peripheral blood of WW^v anemic mice for almost 16 days but were always present in the blood of normal ww mice. Normal ww and anemic WW^v mice suffered similar destruction of marrow, with effects observable during the first 2 days after irradiation. Marrow regeneration occurred rapidly in normal mice, with great increases in cellularity between the second and fourth days after irradiation. By the eighth day, marrow from irradiated normals could not be distinguished from control normal marrow. Marrow regeneration was greatly delayed in WW^v mice. Slight evidence of the beginning of regeneration could be seen on the eighth day after irradiation, followed by increasing cellularity and regional repopulation at 12 and 16 days. By day 23, marrow cellularity of anemics approached pretreatment levels. Anemic and normal mice showed the same postirradiation changes in lymphocyte numbers and the same reduction in neutrophile numbers. The anemic mice showed some delay in neutrophile replenishment. The genetic difference in radiosensitivity between normal ww and anemic WW^v mice is caused very largely by their differential rates of regeneration of erythropoietic tissue. (auth)

5098 MODIFICATION OF RADIOSENSITIVITY OF GENETICALLY ANEMIC MICE BY IMPLANTATION OF BLOOD-FORMING TISSUE. Seldon E. Bernstein (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Radiation Res., 20: 695-702(Dec. 1963).

The dependence of acute radiation sensitivity on the genotypes of the functioning blood-forming tissue was demonstrated by testing the radiation reaction of WW^v anemic mice successfully implanted with isologous normal ww blood-forming tissue. The $LD_{50(30)}$ values of such mice was raised from approximately 250 r to about 680 r, a figure approaching the level of normal ww individuals. Modification of radiation sensitivity of carriers of mutant alleles of the W-series in a single dose (W^vw and Ww) has also been achieved by implantation. In each case the LD_{50} value has been increased to a level characteristic of normal mice of this strain. These investigations lead to the conclusion that in the case of the W-series anemias the acute radiosensitivity of the entire organism is, in large measure, dependent on the genetic constitution of the cells residing in the marrow. (auth)

5099 EFFECT OF RADIATION ON INTERMEDIARY METABOLISM OF THE RAT. John H. Rust, George V. LeRoy, James L. Spratt, Gar Bo Ho, and Lloyd J. Roth (Univ. of Chicago and Argonne Cancer Research Hospital, Chicago). Radiation Res., 20: 703-25(Dec. 1963).

Forty-eight hours after irradiation of rats in the lethal dose range, the amount of CO_2 in expired air decreased to 75% of the control value. To investigate the reason for this decrease, some aspects of intermediary metabolism were studied by using C^{14}-labeled substrates. The fraction of substrate carbon recovered as $C^{14}O_2$ in expired air (ARO) was significantly reduced postirradiation when the tracers were acetate, ribose, glucose, and fructose. At earlier times, and with lower doses of radiation, there was either no effect, or there was a decrease that was not statistically significant. The movement of CO_2 was not affected when $NaHC^{14}O_3$ was the tracer. The ARO of formate was increased. Irradiation had no influence on the C_6/C_1 ratio in $C^{14}O_2$ when the tracers were glucose-1 and glucose-6. Incorporation of glucose and pyruvate (as alanine) into glycogen was increased severalfold. The transfer of carbon from glucose into urea was impaired by radiation, but that from alanine was not affected. With bicarbonate as the tracer, fixation of CO_2 in liver glycogen was more than seventy times as great in the irradiated rats as in the controls. These findings are interpreted as follows: the reduced output of CO_2 in expired air postirradiation is not satisfactorily accounted for by impairment of oxidation of the substrates used; liver glycogen is increased as a result of enhanced glycogenesis and gluconeogenesis; and the increased fixation of CO_2 in liver glycogen suggests that fat may become an important precursor for gluconeogenesis in the irradiated rat. It was concluded that irradiation in the lethal dose range has an influence on intermediary metabolism the significance of which cannot be evaluated fully with the data at hand. (auth)

5100 EFFECT OF X-IRRADIATION ON THE FRAGILITY OF RAT SPLEEN LYSOSOMES. Y. E. Rahman (Argonne National Lab., Ill.). Radiation Res., 20: 741-50 (Dec. 1963).

The effect of various treatments on the release of acid phosphatase from spleen homogenates of irradiated rats

was studied. Enzyme release increased 3 and 24 hr after a single dose of 1000 r of whole-body x irradiation. Spleen homogenate irradiated in vitro did not show increased acid phosphatase release. Rats injected with thyrotropic hormone or spleen homogenate treated with L-thyroxine in vitro showed an effect on enzyme release similar to that of x irradiation. Thus, the x-ray effect on this enzyme release cannot be attributed to a direct action on membranes of acid phosphatase-containing particles of the cells but is apparently mediated through a hormonal mechanism. (auth)

5101 FATAL COMPLICATIONS OF RADIATION INJURIES TO SKIN. Jaromir Kolar, R. Vrabec, and Z. Kral (Charles Univ., Prague). Radiobiol. Radiother., 3: 421-7(1962). (In German)

Three cases of fatal ulcerations produced by irradiation for cancer or metastases are described. The first case was irradiated postoperatively for mammary cancer. Skin necrosis appeared four years later and was repaired by transplants. Minor recurring skin surface erosions were repaired conservatively. Subsequent to later irradiation for parotid carcinoma, new erosion of the cicatrix with depigmentation, telangectasis, atrophy, and irregular deep ulceration with pus secretion appeared. No malignant degeneration was observed, but the thoracic wall perforated at the ulceration site and was followed by lung fibrosis, radionecrosis of the lung, spontaneous fracture of three ribs, empyemia, and terminal circulatory failure. The second patient was irradiated three times in two years for leukemia and polycythemia vera. Three months after an ulcer appeared in the right inguinal area where a metastatic lymph node had been irradiated. The first radiation series (2400 r) had been given in single doses of 300 r in three weeks, and each of the second and third series amounted to 1200 r given over 2-month periods. The ulcer became progressively necrotic, erosion of the femoral artery followed, and the patient expired from hemorrhage. No evidence of malignancy was found in the ulcerated tissue. The third patient was irradiated in the inguinal area after partial castration for testicular seminoma with inguinal metastases. In one series he received 3000 r in the right inguinal area (single dose, 400 r). Skin necrosis soon followed. The lesion whitened in the area of the femur neck. The bone showed hypertrophic atrophy. Two years after plastic reconstruction the lesion reappeared and deepened, and after repeated operative repairs the patient died of hemorrhage from the femoral artery. (BBB)

5102 CLINICAL RESEARCH ON THE PROBLEM OF IRON METABOLISM IN X IRRADIATION. A. Morczek (Strahleninstitut der Medizinischen Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 3: 445-50(1962). (In German)

In women undergoing thoracic radiotherapy for mammary carcinoma in fractionated doses the iron content of serum increased during the first 10 days followed by a slight decrease. After irradiation of the abdomen for uterine carcinoma, following a similar initial increase, there was a continuous decrease in serum iron content. The increase of serum iron presumably resulted from inhibition of iron utilization by blood-forming tissue. The prolonged decrease of iron in serum following irradiation of the abdomen is explained by impaired iron absorption due to injury to the intestinal mucous membrane. There was no marked change in the total iron-binding capacity of serum after irradiation. Only a minimal splitting off of iron from the hemoglobin molecule results from irradiation; therefore, as a diagnostic criterion, changes in serum iron content can only be interpreted in relation to other postirradiation symptoms. (BBB)

5103 BONE SARCOMAS FOLLOWING RADIATION THERAPY. Theodore L. Phillips and Glenn E. Sheline (Univ. of California, San Francisco). Radiology, 81: 992-6 (Dec. 1963).

Two cases of osteogenic sarcoma arising in irradiated bone are reported. They developed in patients treated for carcinoma of the breast and of the cervix. Both occurred in previously normal bone. The latent period was eleven years in one and five years in the other. To evaluate the incidence of this complication, the number of malignant tumors irradiated and the number of five-year survivors were determined. Of almost 6,000 patients treated, sarcomas developed in only 2, an incidence of 0.03% or 0.1% of the 2,300 five-year survivors. Although radioinduction of bone sarcoma apparently does occur in normal bone, it is a rare complication of radiotherapy for malignant disease. (auth)

5104 THYMINE DIMERS AND INHIBITION OF DNA SYNTHESIS BY ULTRAVIOLET IRRADIATION OF CELLS. R. B. Setlow, P. A. Swenson, and W. L. Carrier (Oak Ridge National Lab., Tenn.). Science, 142: 1464-6(Dec. 15, 1963).

Measurements of the inhibition of DNA synthesis in bacteria and the formation of thymine dimers by ultraviolet irradiation of the cells indicate that one thymine dimer per 350-μ strand of DNA acts as a block to further synthesis. In a sensitive strain of Escherichia coli the blocks are premanent. In a resistant strain the blocks are only temporary but recovery of synthesis is not the result of splitting dimers. (auth)

5105 CHANGES IN HISTAMINE-STIMULATED AND BASAL SECRETIONS OF THE STOMACH FOLLOWING X-IRRADIATION OF DOGS. Ou-yang Yen, Chu-heng Lin, and Jen-pao Chu. Sheng Li Hsueh Pao, 25: 7-14(1962).

One group of dogs (I) was injected with histamine or a histamine-atropine mixture, while a second group (II) was exposed to 250 r of x radiation. The volume of gastric secretion decreased gradually in group I and increased in group II. Gastric secretion in the irradiated dogs was inhibited when irradiation was followed by an injection of histamine. (OTS)

5106 THE EFFECT OF TOTAL BODY X-IRRADIATION OF A DOG ON GASTRIC SECRETION AFTER FEEDING. Ou-yang Yen and Jen-pao Chu. Sheng Li Hsueh Pao, 25: 15-23(1962).

Dogs fitted with Heidenhain pouches and pouches of lesser curvature were exposed to whole-body x irradiation of 250 r. After exposure they were fed and the volume of gastric secretion was measured. Compared with pre-exposure levels, gastric secretion and acidity increased in the Heidenhain pouches but decreased in the pouches of lesser curvature. At the end of the observation period (3 months after exposure), the gastric function of animals was still below normal. (OTS)

5107 SEQUENCE OF CHANGES IN PANCREATIC SECRETION FOLLOWING TOTAL-BODY IRRADIATION. Yun-hsiang Chang, K'o-ming Tai, and Jen-pao Chu. Sheng Li Hsueh Pao, 25: 24-8(1962).

Investigation of the volumetric changes in the pancreatic secretion of four dogs after x irradiation (250 r) showed a decrease of secretion in two animals, an increase in one, and no change in the fourth. When dilute HCl was intro-

duced into the duodenum before and after irradiation, the volume of pancreatic secretion declined following exposure; the decline was accompanied by a reduction in the pancreatic amylase concentration. (OTS)

5108 THE EFFECT OF DIFFERENT DOSAGES OF GAMMA RADIATION ON CHROMOSOME ABERRATIONS IN THE SPERMATOGENESIS OF THE RHESUS MONKEY, MACACA MULATTA. Chia-cheng T'an, Tsu-tung Liu, Chung-shu Chang, Hsin-fang Ch'iu, Chao-tsu Lei, and Ching-lun Hsueh. Shih Yen Sheng Wu Hsueh Pao, 7: 386-97(1962).

The testes of 9 monkeys were irradiated with γ radiation from a Co^{60} source; one testicle from each animal was irradiated while the other served as a control. The testes were then removed and examined. No effects on the frequency of chromosome aberrations were noted following irradiation at doses of 5 to 50 r. However, radiation dosages of 50 to 400 r caused an exponential increase in chromosome aberration frequency. It was concluded that the correlation between radiation dosages and the chromosomal aberrations in primates closely parallels those observed with lower animals and plants. (OTS)

5109 INVESTIGATION OF RADIATION PROTECTION MEASUREMENTS FOR MIXED RADIATION. THE FIRST JOINT RELATIONS BETWEEN NEUTRONS AND TISSUE. Hans Schreiber and Wolfgang Peters (Versuchs- und Ausbildungsstätte für Strahlenschutz, Neuherberg, Ger. and Flugwissenschaftlichen Forschungsanstalt e.V., Münich). Strahlentherapie, 122: 384-96(Nov. 1963). (In German)

The tendency to use higher quantum energy as well as radiation intensity stresses the importance of the neutrons and their reactions with nuclei. In organic tissues only a limited number of reactions is possible that can be specified for a known atomic composition of the tissue and known energy of the neutrons. The atomic composition of two different kinds of tissue (striated muscle and bone) of the "standard man" was computed. These data and those known from neutron physics show the importance of hydrogen for the primary biological effect of neutrons. For slow and fast neutrons a distribution pattern of the nuclear reactions in organic tissue was computed and discussed. Information about the relative frequency of the reactions, given by the probability of their occurrence at the first collision, is included. (auth)

5110 THE PRESENT KNOWLEDGE OF THE MECHANISMS OF UV EFFECTS ON THE HUMAN SKIN. Arthur Wiskemann (Universität, Hamburg). Strahlentherapie, 122: 463-71(Nov. 1963). (In German)

Biochemical changes in structural elements of the skin as determined photochemically in vitro and in vivo are discussed. The nucleid acids, albumins, globulins, structural proteins, enzymes, and sulfur-containing and free amino acids are discussed. The importance of the radiation products in production of inflammation by light, the reduction acceleration, and light-induration as well as direct and indirect pigmentation is discussed. (auth)

5111 MULTIPLE SCLEROSIS, GEOMAGNETIC LATITUDES, AND COSMIC RAYS. John S. Barlow. Trans. Am. Neurol. Assoc., 85: 189-91(1960).

Available statistics on multiple sclerosis were examined from the standpoint of geomagnetic latitude. When morbidity and mortality for multiple sclerosis was plotted against geomagnetic latitude, good agreement was observed. Thus relatively high prevalence ratios (e.g., 40-60 per 100,000 population) can be predicted for locations of geomagnetic latitude approximately 48° or greater, whereas relatively low prevalence ratios (e.g., 4-6 per 100,000 population) are predicted for locations of geomagnetic latitudes of ~38° or less. Subsequently, other factors that are dependent upon geomagnetic latitude (auroras and cosmic ray intensity) in turn were examined. Auroras did not appear to be a promising lead. It was concluded that the ionization produced by cosmic rays is not itself a direct cause of the disease due to the fact that it not especially prevalent in those areas of a high background radiation level from terrestrial sources. It is conceivable that geomagnetic latitude and cosmic rays act through intermediary factors, such as through specific types of radioactivity induced by cosmic rays (C^{14} or S^{35}). (BBB)

5112 INVESTIGATION OF THE CLEAVABILITY OF AUTOXIDIZED, EPOXIDIZED, HYDROXYLATED, AND IRRADIATED SOYA OIL BY PANCREATIC LIPASE AND LIVER ESTERASE IN VITRO. E. Degkwitz and K. Lang (Universitat, Mainz). A. Ernaehrungwiss., 3: 170-5 (May 1963). (In German)

Intestinal absorption of autoxidized and β-irradiated soya oil in rats was reduced, compared with hydroxylated and epoxidized oils. Both autoxidized and irradiated oils remained much longer unchanged in the digestive tract, interfering with its function. Soya oil was irradiated by use of a van de Graaff electron accelerator operated at 0.5 Mev, autoxidized at 180°C, or epoxidized according to the method of Gall and Greenspan. For hydroxylation, 1 kg epoxidized soya oil was used, mixed with water and sulfuric acid, constantly stirred for 2 hr at 100°C, cooled, washed acid-free, and dried. The enzymic digestibility of untreated soya oil was low, that of treated soya oils slightly lower, as tested in vitro with pancreatic lipase and liver esterase. In the case of autoxidized and irradiated oils this could not explain the observed decreased intestinal absorption since hydroxylated and epoxidized oils with unchanged absorption rates were equally resistant to enzymic cleavage. (BBB)

5113 HISTOPATHOLOGY IN ALBINO MICE AND RHESUS MONKEYS INFECTED WITH IRRADIATED CERCARIAE OF SCHISTOSOMA JAPONICUM. H. F. Hsu, J. R. Davis, S. Y. Li Hsu, and J. W. Osborne (Univ. of Iowa, Iowa City). Z. Tropenmed. Parasitol., 14: 240-61(July 1963).

A comparative study was made on the histopathology of mice and monkeys infected once or several times with cercariae of the J strain which had been x-irradiated with different doses (1700 to 4800 r). Results showed that the fate of the migrating schistosomula in mice varies with the amount of irradiation. With x-ray exposures of 1700, 3000, and 6000 r the migrating schistosomula were destroyed in liver; with 12000 r the skin, lungs, and liver played nearly equal roles in schistosomulic extinction; with 24000 r the schistosomula were usually destroyed in skin, seldom in lungs, but never in liver; and with 48000 r all the schistosomula perished in the skin. The differences in timing, rate, and site of schistosomulic destruction in mice between a group infected once with x-irradiated cercariae and another group infected twice with the same kind of cercariae were not significant at 3000 r or 6000 r, but were significant at 12000 r and 48000 r. However, if the reinfection was given four times, similar differences were significantly shown even with mice infected with cercariae exposed to 3000 r. The effects produced by the repeated infections were demonstrated as an early appearance and increased intensity of

the inflammatory reaction. In extreme cases the site of schistosomulic destruction shifted from liver to lung and skin. The fate of migrating schistosomula and their histopathology in rhesus monkeys infected either once with cercariae exposed to 3000 r and 48000 r or five times with cercariae exposed to 3000 r was similar to those in mice. The results showed that the secretory ability of the cephalic glands of the cercariae inoculated was not injured up to 48000 r because it was demonstrated that they could pass through the epidermis and reach the dermis and subcutis. However, high doses may have impaired their ability to produce enzymes necessary for penetration of cutaneous blood vessels, explaining why they were eventually destroyed extravascularly in the dermis and subcutis. Similarly, irradiation might inhibit schistosomulic metabolism and growth in lung and interfere with digestion and assimilation of nourishment in liver. (BBB)

5114 THE GENETIC BASIS OF SOMATIC DAMAGE PRODUCED BY RADIATION IN THIRD INSTAR LARVAE OF DROSOPHILA MELANOGASTER. I. DEATH BEFORE MATURITY. Wolfram Ostertag (Universität, Munster, Ger.). Z. Vererbungslehre, 94: 143-62(1963).

Possible mechanisms of chromosomal radiation damage to somatic cells was investigated in regard to dose relations for survival in both sexes, effect of heterozygous deficiencies on radiosensitivity, effect of variation in target size on radiosensitivity, effect of the Y chromosome on radiosensitivity, and effect of post-treatment with nitrogen. When third instar larvae are exposed to x radiation doses ranging from 2800 to 4900 r, more males than females die before emergence and during the first five days of life. This differential mortality persists beyond the fifth day, at least at 1400 r. Females are heterozygous for a sex-linked deletion and have about the same induced mortality as males, as shown for two deficiencies at different loci, one (N^g) with a dominant effect on phenotype, the other (ct^-) without phenotypical effect in the heterozygote. In females heterozygous for the cut deficiency, normal radiosensitivity could be restored by an autosomal duplication of the deleted section. Females homozygous and males hemizygous for ct^- were also protected by the autosomal duplication, but to a much lesser extent than heterozygotes. Ring-X males are more radiosensitive than rod-X males. Female mortality is not affected by heterozygosity for a ring-X, except when the rod-X carries a deficiency, in which case the female shows the same mortality as a ring-X male. Attached-X females are more radiosensitive that detached-X females, but only slightly more sensitive than normal males. Attachment of a whole Y chromosome to the $X(Y^S \cdot X \cdot Y^L)$ increased mortality of males and heterozygous females slightly after irradiation with 2800 r, and markedly after 3500 r. This effect was noticeable only at emergence; survival during the first five days after emergence was not affected by the attached Y chromosome. There was no difference in radiosensitivity between males with a normal Y and with a ring-Y. Heterozygosity for an autosomal deficiency increases radiosensitivity of both sexes. This was found for two deficiencies, with different phenotypic effects and at different loci on chromosome II (vg^D and Px^2). The higher rate of mortality persisted beyond the first five days after emergence. Quantitatively, the increase in mortality caused by either deficiency was nearly the same and was about twice that due to the difference between the sexes. Posttreatment with nitrogen increased radiation-induced mortality in both sexes to the same extent as a higher dose of radiation. Findings agree with the hypothesis that chromosome loss following breakage is the main cause of somatic radiation damage in Drosophila. Thus the greater radiosensitivity of the males would be due to their possessing only one X chromosome. Cellular damage or death results whenever a portion of the genome is no longer represented in at least haploid condition. Monosomaty for either of the long autosomes does not appear to be detrimental to somatic cells. (BBB)

5115 IRRADIATION OF CELLS IN TISSUE CULTURE. VIII. MORPHOLOGICAL OBSERVATIONS OF NEUTRONS FOLLOWING COBALT-60 GAMMA IRRADIATION OF DORSAL ROOT GANGLIA FROM THE NEWBORN RAT. M. R. Quastel (Hadassah Univ. Hospital, Jerusalem) and C. M. Pomerat. Z. Zellforsch., 59: 214-23(1963).

Attempts were made to develop a method of characterizing the degree of radiation damage to neuronal cells in the absence of a vascular bed, using cultured explants from the dorsal root ganglion of the newborn rat. Cobalt-60 γ irradiation doses to the culture chambers varied from 5000 to 10000 r, at dose rates of 1000 to 9500 r/min. Morphologic changes observed postirradiation were: reduction of the average cytoplasmic and nuclear areas, peripheral displacements of the nuclei, and alterations in cytoplasmic organization. At a dose of 7200 r, manifestations of injury to the neurons were not observed until at least a week after irradiation. However, at 20500 r, marked changes were seen within four days after irradiation. At 100000 r complete neuronal destruction occurred. Characteristic of the neuronal response to radiation was the individual variation of sensitivity: at 41000 r, some neurons were found to exhibit nuclear rotation 42 days after exposure. Following irradiation the position of the nucleus in most neurons became peripheral or bulged partly or almost entirely out of the cell. This phenomenon increased in incidence following irradiation, especially at the higher dosages. The reduction of the mean cytoplasmic area of neurons following a dose of 7200 r is ~70% of the control values 10 days postirradiation. Following a dose of 20500 r a more marked and rapid reduction in the average cytoplasmic area occurred, dropping to about 50% of the unirradiated control values within three days. After this period, a more gradual fall was observed for 19 days postirradiation. At this dose, almost all neurons appeared to be damaged, although a few retained normal size and appearance. Morphological changes of the nuclei were not marked. However, a significant reduction in nuclear area was seen by 10 to 11 days postirradiation at 7200, 20500, and 41000 r. About 50 to 70% of the neurons survived for 10 days after 20500 r and about 5 to 10% survived after 41000 r. Less than 5% of neurons remained alive 20 to 30 days after 41000 r, and after 100000 r, given at 9500 r/min, all neurons were destroyed within four days. It is concluded that the extent of neuronal injury is dependent upon the dose of radiation received and the time elapsed after exposure. While the morphological effects observed may not be specific for radiation injury, they may serve as an indication of the degree of neuronal radiation damage. (BBB)

5116 THE EFFECT PROPORTIONAL TO DOSAGE RATE OF GAMMA IRRADIATION ON THE INCREASE OF PEROXIDE DERIVATIVES OF FATTY ACIDS IN WHEAT LEAVES. B. I. Pozsar (South-Eastern Transdanubian Inst., Iregszemcse, Hungary). p.237-42 of "Symposium on Genetics and Wheat Breeding." Budapest, Magyar Tudomanyos Akademia Konyvtara, 1962.

Dry wheat seeds were sown in the autumn immediately

after Co^{60} γ irradiation at 5, 10, 20, 30, and 60 kr. At the end of vegetative development but before phenological appearance of the generative phase, content of peroxide derivatives of the fatty acid components of the ether-soluble fraction of the leaves was determined. Quantitative determination of peroxide derivatives was also carried out in relation to the dose. Incorporation of S^{35}-labeled sulfate into leaf protein was also followed in relation to phosphorus metabolism (it was previously shown after 16 kr that the acid-labile phosphate fraction is diminished even six weeks after irradiation by 30 to 50%). The peroxide content of the ether-soluble fraction increased proportionally with the dose, reaching a 9-fold higher level after 60 kr. Sulfate-$S^{35}O_4$ incorporation into leaf protein was stimulated after 5 and 10 kr 10 to 40% but inhibited to 47 and 21% of the control value after 40 and 60 kr, respectively. The proportionate increase of peroxide derivatives of fatty acids in the ether-soluble fraction under the influence of irradiation may be explained by the injurious consequences of ionizing radiation in wheat leaves. The increased uptake and accumulation of a nutrient anion as well as its incorporation into fractions of high and low molecular weight appear to be due to activated hydrogen transport and increase in cell respiration at low dosage. The reduction of cell respiration and energy metabolism under the influence of higher doses reduces amino acid synthesis and protein metabolism. After irradiation in vivo, oxidative phosphorylation is uncoupled from respiration and accumulation of peroxide derivatives of fatty acids and formation of fatty acid analogs of a physiologic structure may also occur. These fatty acid analogs may act as antimetabolites and inhibit specifically lipid metabolism. (BBB)

5117 DIFFERENTIAL YIELDS OF MUTATIONS FROM THE FIRST AND SECOND MATINGS AFTER IRRADIATION OF MATURE SPERM IN DROSOPHILA MELANOGASTER. Jeanne Coyne Mossige (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). p.253-74 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

Young males of Drosophila melanogaster yield lower frequencies of sex-linked lethals and II to III translocations over the age range tested, from newly eclosed to 7 days for lethals and from newly eclosed to 3 days for translocations. The first sperm available in the newly eclosed males, 0 to 4 hr old, yield the same frequencies of both translocations and sex-linked lethals when irradiated in nitrogen or air, but the frequencies are enhanced in oxygen. When the sperm have been stored for 3 days in the male there is both a decrease in N and an increase in O as compared to air. It is concluded that the most mature sperm in 0 to 4-hr-old males are relatively anoxic. When irradiated in N, air, or O these young sperm give a decreased frequency of sex-linked lethals from the first to the second mating with single females, and a continued decrease of the lethal frequency with time up to about 24 hr. Sperm irradiated in 2-day-old males in air also show a marked decrease from the first to the second mating and a further decrease in the frequency with time up to about 9 hr. In 7-day-old males there is a decrease from the first to the second mating immediately after irradiation but no further decrease with time. In 3-day-old males irradiated over a dose range of 445 to 3000 r in air, N, and O there was a tendency toward a decrease from the first to the second matings, within 5 hr, in air and O, but none in N. It is suggested that the decrease often observed between first and second sperm batches is due both to a difference in O sensitivity between the first sperm available and those next in line in males of all ages, and to a recovery with time of all mature sperm from males at least up to 2-days-old, which is independent of the atmosphere in which the irradiation was performed. (auth)

5118 DOSE-DEPENDENCE OF THE FREQUENCY OF RADIATION-INDUCED RECESSIVE SEX-LINKED LETHALS IN DROSOPHILA MELANOGASTER, WITH SPECIAL CONSIDERATION OF THE STAGE SENSITIVITY OF THE IRRADIATED GERM CELLS. H. Traut (Kernforschungszentrum Karlsruhe, Ger.). p.359-74 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963. (KFK 173)

In experiments showing a linear dose-effect relationship for sex-linked recessive lethals in Drosophila males, insufficient consideration has been given hitherto to the dependence of radiation sensitivity on cell stage. The effect of radiation dose on mutation frequency was subjected to a renewed study with emphasis on differential radiosensitivity. The following results were obtained: dose-exponents significantly greater than one for certain dose-ranges, indication of a stepwise increase of lethal rate with dose. Most of the departures from linearity thus obtained are statistically significant. Results are discussed in relation to the mutation by-breakage hypothesis and the problem of position-effect lethals. They seem to confirm Muller's suggestion that at relatively high doses, the linearity of the classical dose-effect curve for recessive sex-linked lethals is caused more or less incidentally by the counteraction of different factors. Furthermore, our findings support the calculations by Zimmer (1960) and Dittrich (1960) showing that curves of the one-hit type may not necessarily be the result of one-hit events alone, but also, of the biological variability of the irradiated material with respect to hit number and formal target volume. (auth)

5119 STERILIZATION OF DACUS OLEAE BY GAMMA RADIATION. H. Thomou (Democritus Nuclear Research Centre, Aghia Paraskevi, Attica, Greece). p.413-24 of "Radiation and Radioisotopes Applied to Insects of Agricultural Importance." Vienna, International Atomic Energy Agency, 1963.

Three developmental stages of the olive fly were exposed to gamma radiation from a Co^{60} source and the sterilization dose was determined. For the fourth-instar larvae the sterilizing dose was 2000 ± 300 rad, for the pupae 11,000 to 15,000 rad, and for the adults 15,000 to 18,000 rad. Mating studies showed that the sterility lasted throughout the life of the adults. The effect of dose on emergence was studied with fourth-instar larvae and on the pupae at daily intervals. The larvae were exposed to 300 to 3000 rad at 300-rad intervals, while the pupae were exposed to 3000 to 15,000 rad at 3000-rad increments. Maximum emergence was obtained when eight-day-old pupae were irradiated at the above-mentioned dose-rates. Significant fluctuations occurred at all dose-rates. (auth)

5120 DISINFESTATION OF DRIED FIGS BY GAMMA RADIATION. C. P. Papadopoulou (Democritus Nuclear Research Centre, Aghia Paraskevi, Attica, Greece). p.485-91 of "Radiation and Radioisotopes Applied to Insects of Agricultural Importance." Vienna, International Atomic Energy Agency, 1963.

Dried figs are among the main export products of Greece. Serious damage is caused by insect attack each year. Results are reported from studies on the use of γ radiation in insect control in stored figs. The research work aimed at determining the doses of radiation required to destroy certain species of insects attacking dried figs at their various

stages of development, or to destroy their eggs and thus prevent reproduction; and determining the physical and chemical changes of the texture of dried figs caused by radiation. Studies were made on the following species: Plodia interpunctella, Ephestia cautella, Carpophilus hemipterous, Oryzaephilus surinamensis, and Lasioderma serricorne. The optimum doses required are discussed. At these doses, irradiation damage does not become apparent in the texture of the figs. (auth)

5121 LEIKOZY I RADIATSIYA. (Leukemia and Radiation). E. D. Gol'dberg. Tomsk, [USSR], Publishing House of Tomsk University, 1963. 73p.

The occurrence of leukemia after exposure to radiation is investigated. The effects of natural background radiation and the occurrence of leukemia in scientific and medical personnel and patients exposed to x radiation are discussed. Statistics are given for the occurrence of leukemia among the Japanese people exposed to the atomic explosion. (C.E.S.)

5122 LUCHEVYE PORAZHENIYA I KOMPENSATSIYA NARUSHENNYKH FUNKTSII. (Radiation Injuries and Compensation of Damaged Functions). Yu. G. Grigor'ev. Moscow. Gosatomizdat, 1963. 203p.

Experimental and clinical results on the effects of ionizing radiation on physiological functions are presented. The characteristics of these effects and the problem of compensation for disrupted functions are discussed. A great number of references are cited. (C.E.S.)

5123 BIOLOGICAL EFFECTS OF IRRADIATION. Gould A. Andrews. p.71-93 of "Proceedings of Nuclear Energy Conference." [Russellville, Arkansas, Arkansas Polytechnic College, 1963].

The biological effects of radiation are discussed from the viewpoint of patients who have received radiation for diagnosis or therapy. Discussion is given on somatic and genetic effects, factors influencing radiation effects, acute whole-body radiation in man, late radiation effects, and beneficial biological applications of irradiation. (P.C.H.)

5124 CHANGES IN HEMOPOIESIS DURING PROLONGED INTERNAL ADMINISTRATION OF ^{60}Co. N. L. Beloborodova. p.44-60 of "Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Hemopoiesis and the detection of early signs of its impairment were studied during prolonged daily Co^{60} administration in rabbits. The animals were divided into three groups: the control group, one group receiving 1.25 μC/kg Co^{60} daily, and one group receiving 12.5 μC/kg Co^{60} daily. For detection of functional failures of hemopoietic organs, as well as a monthly examination of the peripheral blood and bone marrow, certain physiological stresses such as pregnancy and blood loss were used. At the end of the experiment the morphological composition of the bone marrow and spleen of all the animals killed was studied by contact preparation. With prolonged daily administration of Co^{60} impairment of erythropoiesis and lymphopoiesis was observed, the degree of which was proportional to the quantity of isotope administered. In the first group of rabbits, which received 1.25 μC/kg Co^{60}, impairment of lymphopoiesis was expressed in a certain retardation of lymphocyte maturation, which under ordinary experimental conditions did not produce a decline of the absolute lymphocyte number in the peripheral blood. In the second group, which received 12.5 μC/kg Co^{60}, the absolute lymphocyte number began to decline from the first month of administration and after 6–7 to 10 months steady absolute lymphopenia developed. Retardation of the lymphocyte maturation processes in the spleen was more pronounced than in the animals of the first group. (H.M.G.)

5125 HEMOPOIESIS IN THE OFFSPRING OF RATS WHICH HAVE UNDERGONE PROLONGED ^{60}Co ADMINISTRATION. N. L. Beloborodova, V. L. Viktorova, and E. K. Red'kina. p.61-73 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Results of investigations of hemopoiesis in the offspring of rats that had received 150 μC/kg Co^{60} per day are considered. The amount of Co^{60} given was sufficient to produce an average dose of 1 rep per day. Administration was begun 21 days before pregnancy and was continued throughout gestation and after birth. The quantity of Co^{60} administered produced no pronounced symptoms of radiation sickness in the females either during or after pregnancy. The level of radioactivity in the newborn rats was 0.03–0.07 μC/kg. This level declined slowly. The number of young rats in the litter, duration of pregnancy, weight, and their general condition and development were normal. Study of the hemopoietic processes disclosed the impairment of erythropoiesis, mainly in the spleen, in which progressive active hyperplasia of the erythroblastic tissue was observed. (H.M.G.)

5126 CHANGES IN THE FRACTIONAL COMPOSITION OF THE SEROUS PROTEINS AND RESIDUAL NITROGEN CONTENT OF RABBITS DURING CHRONIC INTERNAL ADMINISTRATION OF ^{60}Co. E. D. Grishchenko. p. 74-89 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Changes in the content and composition of the protein fractions of the blood serum in rabbits were investigated during daily oral administration of Co^{60} in doses of 12.5 and 1.25 μC/kg for 23 months. In the first 7 to 9 months the total serous protein content increases significantly due to the globulin fraction (approximately from 6.40 to 7.40 per cent), as a result of which the albumin to globulin (A/G) ratio falls. In the period from the 9th to the 14th months of administration total protein returns to its normal level (probably as a result of hemoconcentration), and then also the A/G ratio. Subsequently, total protein again rises to a higher point than before and the A/G falls as a result of an increase of the γ-globulin fraction, demonstrated by paper electrophoretic studies. The character of the changes produced by physiological stress (blood loss) at the 15th month indicates a weakening of the albumin synthesizing processes. No substantial changes in the residual nitrogen content of the blood serum could be detected throughout the experiment apart from a slight increase at the 4th month. (auth)

5127 THE EFFECT OF ^{60}Co ON CARBOHYDRATE METABOLISM IN RAT LIVER. N. I. Vinogradova. p.90-7 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

White rats were given 15 to 900 μC quantities of $Co^{60}Cl_2$ either orally or intraperitoneally. At different intervals after administration the animals were decapitated, and the phosphorylytic and amylolytic activity of liver extracts was measured. After a single intraperitoneal injection of 22–44 μC Co^{60} per rat (100–250 μC/kg weight) the glycogen content of the liver was unchanged. A day after administration of 100 μC/kg and more (500 μC/kg and more) the glycogen content of the liver declines and phosphorylase

activity was depressed. Oral and intraperitoneal administration of rats of 100 μC/kg Co^{60} and more, produced formation in the liver of glycogen with shortened side chains. (auth)

5128 IMPAIRMENT OF SOME ASPECTS OF CARBOHYDRATE-PHOSPHORUS METABOLISM IN RABBITS AFTER PROLONGED ADMINISTRATION OF ^{60}Co. N. I. Vinogradova and E. D. Grishchenko. p.98-107 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Investigations of liver homogenate phosphorolytic and amylolytic activity and of glycogen structure in rabbits during chronic oral Co^{60} administration are considered. Six groups of young rabbits were studied: 10 rabbits received $Co^{60}Cl_2$ in a daily dose of 1.25 μC/kg weight; thirteen received 12.5 μC/kg $Co^{60}Cl_2$ daily; five were given 1.9 γ stable cobalt daily; five received 19 γ stable cobalt daily; four received 65 μC/kg $Co^{60}Cl_2$ daily for two months and; ten rabbits served as controls. Blood sugar level was found to be little changed, exhibiting only a tendency to rise towards the end of the experiment period of 21 to 23 months. At the 15th to 16th month after loading with glucose, the sugar curves have a clearly hypoglycemic character. At the 18th month they become normal but at the 21st to 23rd month significant hyperglycemia develops. Hyperglycemia results from direct damage to the enzymic systems of the liver. Phosphorylase activity is primarily affected, whereas amylase is harmed much less by radiation energy. The glycogen content of the liver differed little from the control in all the experiments. Glycogen structure is significantly modified: in the rabbits subjected to 65 μC/kg Co^{60} it is almost completely divested of side chains (breakdown by β-amylase in 6%); in the rabbits receiving 12.5 μC/kg Co^{60} the side chains are shortened by half (breakdown by β-amylase is 25%); in rabbits receiving 1.25 μC/kg Co^{60} the glycogen side chains are of normal length (glycogen breakdown by β-amylase is 45%; in the control 47%). (H.M.G.)

5129 CHANGES IN CAPILLARY PERMEABILITY OF EYES AND SKIN OF RABBITS DURING CHRONIC INTERNAL ADMINISTRATION OF ^{60}Co. A. A. Rubanovskaya. p.108-18 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Capillary permeability of the eyes and skin was studied in 13 rabbits receiving 12.5 μC/kg weight oral daily doses of Co^{60}. The permeability of the hepato-ophthalmic barrier and the skin were studied as guides to the general condition of vascular permeability. Two tests were used for investigating capillay permeability of the eye: permeability to flourescein and the protein content of the anterior chamber aqueous humor. A skin trypan test was used for the study of cutaneous permeability. Permeability of the eye capillaries to fluorescein and protein was impaired only after 7 to 9 months of daily administration of 12.5 μC/kg Co^{60}. A pronounced tendency for skin permeability to increase was detected only after 9 to 11 months of chronic internal Co^{60} irradiation. The impairment of vascular permeability is one of the later manifestations of chronic radiation sickness produced by internal administration of Co^{60}. Changes in vascular permeability under conditions of chronic internal irradiation by Co^{60} are slight and presumably consist in functional disturbances. (H.M.G.)

5130 ELECTROCARDIOGRAPHIC INVESTIGATIONS OF RABBITS DURING PROLONGED INTERNAL ADMINISTRATION OF SMALL DOSES OF STABLE AND RADIOACTIVE COBALT. A. O. Saitanov. p.119-39 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Systematic electrocardiographic investigation was carried out for 22 months on healthy young rabbits. Five groups of animals were given either 1.25 μC/kg Co^{60}, 12.5 μC/kg Co^{60}, 1.9 γ stable cobalt, 19 γ stable cobalt, or served as physiological controls. In both the control and experimental groups a lability of the sinus rhythm was observed. In more than half the rabbits a normal or sinistral disposition of the cardiac electric axis predominated. The duration of waves and intervals was substantially the same in the experimental as in the control group. The electric ventricular systole in the experimental animals approached the upper limit of the norm twice as often as in the controls. In some rabbits a transitory change of intra-atrial, and in others intraventricular conductivity was observed. Also, electric ventricular alternation was seen in two rabbits. In all experimental rabbits a change in voltage height of the electrocardiogram of a phasic character was noticed. Progressive electrocardiographic examination showed the precise effect of prolonged administration of small doses of Co^{60} in amounts of 1.25 and 12.5 μC/kg on the terminal part of the ventricular complex of the waves (basically the T wave) of the electrocardiogram. Dose dependence of electrocardiographic results was not established. (auth)

5131 THE ELECTROCARDIOGRAM OF RABBITS DURING FUNCTIONAL TESTS (ASCHNER'S TEST, AMMONIA INHALATION AND ADRENALIN INJECTION) IN CONDITIONS OF CHRONIC ADMINISTRATION OF SMALL DOSES OF ^{60}Co. I. N. Golovshchikova. p.140-50 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

The condition of cardiovascular regulatory mechanisms was studied in rabbits given daily oral doses of 12.5 μC/kg Co^{60}. Three functional tests were used: Aschner's test, the olfactory-cardiac reflex with ammonia inhalation, and the reaction to intravenous injection of adrenalin. The first two tests were carried out 12 months after the beginning of the experiment and the third at 18 months. In all cases effects were examined electrocardiographically. No significant difference was found in reactions to Aschner's test between experimental and control rabbits. The ammonia test showed increased sensitivity to ammonia and enlargement of the depressor effect in experimental animals. The adrenalin test produced in the experimental animals deformation of the terminal part of the ventricular complex QRST after normal initial electrocardiographic results. (H.M.G.)

5132 MORPHOLOGICAL CHANGES IN RABBITS DURING CHRONIC INTERNAL ADMINISTRATION OF ^{60}Co. A. S. Kaplanskii. p.151-63 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Morphological changes induced by internal administration of Co^{60} were observed in rabbits receiving 1.25 or 12.5 μC/kg weight daily oral doses of Co^{60}. Animals were killed 22 to 24 months after the beginning of the experiment, and all organs were submitted to histologic examination. Significant pathological lesions were produced in the organs and in a series of cases leads to death of the animal. Chronic administration to rabbits of Co^{60} sharply lowered the body's resistance, In most rabbits the following were noticed: pronounced lesions of the hemopoietic organs; proliferation of cells of the reticuloendothelial system in various organs; so-called specific pneumonias; atrophic and sclerotic lesions of the mucous membrane

of the gastro-intestinal tract; dystrophic, and sometimes even necrobiotic, lesions of the liver; diffuse interstitial focal sclerosis of the kidneys; lesions of the urinary bladder epithelium; dystrophic and atrophic lesions of the gonads. In some cases the following were observed: hemosiderosis of internal organs, intrauterine fetal death, and development of tumors. The degree of evidence of these pathological changes in the organs depended on Co^{60} concentration and the individual sensitivity of the animal. (auth)

5133 THE LONG-TERM EFFECTS OF INTRATRACHEAL INJECTION OF SOLUBLE AND INSOLUBLE COMPOUNDS OF CERTAIN RADIOISOTOPES ($^{24}NaCl$, $Cr^{32}PO_4$ AND COLLOIDAL ^{198}Au). T. A. Kochetkova and G. A. Abrunina. p.174-85 of "The Toxicology of Radioactive Substances. Vol. 2." New York, The Macmillan Company, 1963.

Intratracheal injection of white rats with radioactive insoluble chromium phosphate and colloidal gold gives rise to anaplasia of the epithelium of the bronchial mucosa; in some animals foci of keratinous squamous cell carcinoma appear after 2 to 6 months. In individual animals which received 30 mg chromium phosphate (0.1–0.07–0.04 mC) and died after 7, 11, 15 months, and in animals which received 2 mg (0.04 mC) died at 12, 15, 17 months, keratinous squamous cell carcinoma of the lung, with metastases in the pleura and regional lymph nodes, was detected. No such lesions were observed in the lungs of rats injected with radioactive sodium, even after 24 months. After administration of radioactive sodium chloride, chromium phosphate and colloidal gold, lesions of blood vessel walls, mainly in the lungs, are observed in the form of dystrophic lesions and impairment of permeability with subsequent development of perivascular peribronchial scleroses. In some animals calcareous deposition in the muscle layer of the arteries of the lungs, pia mater, and testes, and formation of bone tissue there and in the plumonary connective tissue were observed. The experimental results obtained raise the problem of the possibility of the occurrence of large tissue radiation doses at foci of deposition of insoluble radioactive compounds. The necessity for stricter regulation of insoluble radioisotopes is indicated. (auth)

Radiation Effects Therapy and Countermeasures

5134 (NP-13281(p.34-44)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. III. THE INFLUENCE OF ORAL ADMINISTRATION OF MIXTURES OF VARIOUS RADIOPROTECTIVE COMPOUNDS ON RADIATION-INDUCED CHANGES IN ENZYME ACTIVITIES IN CERTAIN RAT TISSUES. Bernard E. Hietbrink, Marjorie Keshmiri, and Mary E. Hayward (Chicago. Univ. Air Force Radiation Lab.).

A study was conducted to determine quantitatively the radioprotective activity of the oral administration of various chemical compounds in rats. Doses of 5-hydroxytryptamine creatinine sulfate (serotonin) ranging from 20 mg/kg to 80 mg/kg were given at various intervals before 400 r of x irradiation. It was found that 20 mg/kg of serotonin given from 3 to 15 min before irradiation provided significant reductions in the biological effects of x ray in the spleens, thymus glands, and intestines. Increasing the dose of serotonin to 40, 60, or 80 mg/kg failed to enhance the protective activity of this agent. Experiments undertaken to determine the ability of oral administration of mixtures of serotonin and sulfur-containing compounds indicated that the mixture of serotonin and AET failed to reduce the damaging effects of x irradiation in the tissues studied to the extent afforded by serotonin alone. The mixture of serotonin and MEA provided substantial protection in the spleen when given 15 or 30 min before 400 r of x ray, but failed to reduce the radioinduced changes in the intestine. Protective activity was observed in all tissues studied when the mixture of serotonin and glutathione was given 15 min prior to x ray. This mixture did not provide beneficial effects when administered 5 min. before exposure to 400 r. Administration of 20 mg/kg of serotonin and 1,500 mg/kg of cysteine was less effective than this dose of serotonin given alone in reducing the damaging effects of 400 r. Results of studies on the influence of various radioprotective compounds on the 30-day survival of animals given lethal doses of x radiation showed that oral administration of 40 mg/kg of serotonin permitted survival of one of the five rats given 850 r. Oral injections of mixtures of 40 mg/kg of serotonin plus 500 mg/kg of MEA or 1,500 mg/kg of cysteine and 500 mg/kg of MEA before exposure protected 20% of the animals against the lethal effects of this dose of radiation. Mixtures of cysteine and AET or cysteine and AET plus an intraperitoneal injection of sodium pentobarbital failed to prevent lethality after 850 r of x ray. One of four rats given 1,500 mg/kg of glutathione and 500 mg/kg of MEA 15 min before 850 r survived the 30-day test period. (auth)

5135 (NP-13281(p.45-56)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. I. THERAPY OF RADIATION INJURY IN MICE USING VARIOUS CHEMICAL AGENTS. J. Dilley and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

The post-irradiation administration of cyanide, potassium sulfite plus cyanide, sodium azide, cysteine hydantoin, and 2-iminothiazolidine-4-carboxylic acid was shown to significantly increase the survival time of female CF_1 mice exposed to lethal doses of whole-body x radiation. With the dose of sodium nitrite which was used in these studies, it was not possible to demonstrate similar effects. It seems likely that those agents which are effective after irradiation may act either by preserving the active sulfhydryl groups of some critical protein or by preserving the heme moiety of a vital enzyme system. An attempt was made to prolong the action of cyanide in vivo by pretreating the animals with potassium sulfite to block the enzyme system which detoxifies the cyanide ion. No enhancement of the radioprotective effect of cyanide was seen when the cyanide was given 15 min prior to irradiation exposure. (auth)

5136 (NP-13281(p.57-69)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. II. HISTOPATHOLOGICAL FINDINGS IN THE TISSUES OF MICE PROTECTED AGAINST THE LETHAL EFFECTS OF WHOLE-BODY X-RAY EXPOSURE BY THE POST-IRRADIATION ADMINISTRATION OF SODIUM SULFITE OR A THIAZOLIDINE DERIVATIVE. D. Vesselinovitch, J. Dilley, J. Meskauskas, F. Fitch, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

Gross and microscopic examination of the tissues of x-rayed male and female mice given therapeutic doses of

sodium sulfite or 2-iminothiazolidine-4-carboxylic acid at 30 min after lethal radiation exposure have been carried out. Sodium sulfite and to a lesser extent 2-iminothiazolidine-4-carboxylic acid reduced the radioinduced changes in body weight and in the spleen of mice given 600 r or 700 r of whole-body x radiation. Enhanced recovery of the hematopoietic system was observed in x-rayed mice treated with sodium sulfite or 2-iminothiazolidine-4-carboxylic acid at 30 min after the radiation exposure. Both the myeloblastic and erythroblastic series appeared to be stimulated in the treated irradiated animals, but the myeloblastic series appear to recover earlier. Bone marrow hypocellularity was less pronounced in the x-rayed mice which were treated with sodium sulfite and the appearance of gelatinous marrow was less frequent in these animals. Repopulation of the bone marrow in the x-rayed mice treated with sodium sulfite or 2-iminothiazolidine-4-carboxylic acid was stimulated. (auth)

5137 (NP-13281(p.70-91)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. III. THE INFLUENCE OF VARIOUS CHEMICAL COMPOUNDS ON RADIATION LETHALITY IN MICE. V. Plzak, M. Root, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

Fifty-four compounds were evaluated for protective activity against radiation lethality in CF_1 male mice. Of these, 13 were significantly protective in that they permitted 10% or more of the animals to survive for 30 days after an otherwise lethal dose (750 r) of whole-body x radiation. An additional compound, a porphyrin derivative, permitted 20% of the mice pretreated (200 mg/kg) to survive 600 r of x-irradiation. The two most effective compounds included in the present studies were ST-31 and ST-32 which permitted 40% of the mice to survive for 30 days after x ray exposure. Six derivatives gave 20% 30-day survival. Included in this group were the following: 2-(3-hydroxypropyl)-2-thiopseudourea monohydrobromide (PD-35); 1,4-dihydro-1-(o-mercaptophenyl)-4,4,6-trimethyl-2-pyrimidinethiol (PD-67); 6-amino-3-pyridazinethiol (PD-82); 2-amino-5-(p-aminophenylmercapto)-1,3,4-thiadiazole (PD-85); 5-anilino-1,3,4-thiadiazole-2-thiol (PD-86); and 5-benzylidene-3-benzylideneaminorhodanine (PD-91). The remaining five radioprotective compounds permitted only 10% of the animals to survive for 30 days after the otherwise lethal x-ray exposure. They were 2,2′-dithiobis(5-amino-1,3,4-thiadiazole) (PD-84); ST-28; ST-33; ST-36; and ST-39. (auth)

5138 (NP-13281(p.115-23)) INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. III. THE ANALYSIS OF RADIOPROTECTIVE EFFECTS IN PROTON- OR X-RAY-IRRADIATED MICE PRETREATED WITH CHEMICAL PROTECTORS. D. G. Oldfield, V. Plzak, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

An initial analysis of maximum likelihood estimates of 30-day mean lethal dose and other parameters calculated using IBM 7094 for mice whole-body irradiated by high-energy (440-Mev) protons or by median energy (250-kvp) x rays with and without pre-irradiation treatment with 2-mercaptoethylamine hydrochloride (MEA) or p-aminopropiophenone (PAPP) was made. Only limited agreement with regression of mortality probit on either radiation dose or logarithm of radiation dose was obtained, with indications that regression on dose was the more accurate. The calculated mean lethal doses were not very sensitive to which regression variable was used. The values obtained using dose as the variable were, for protons: controls, 850 rads; PAPP, 1,260 rads; MEA, 1,360 rads; for x rays: controls, 560 rads; PAPP, 880 rads; MEA, 780 rads. From the preceding values, the dose reduction factors (DRF's) for MEA are: 1.61 against protons, 1.39 against x rays; the DRF's for PAPP are: 1.48 against protons, 1.56 against x rays. Thus, based on DRF's, and for the specific drug dosage levels used, MEA is a better protector than PAPP against high-energy proton irradiation, but a poorer protector than PAPP against medium-energy x ray irradiation. (auth)

5139 (JPRS-22123) THE MECHANISM OF ACTION OF PROTECTIVE-THERAPEUTIC COMBINATIONS IN ACUTE RADIATION SICKNESS IN RATS. T. N. Protasova. Translated from Med. Radiol., 8: No. 9, 66-8(1963). 5p. (OTS-63-41281)

Radiation protective–therapeutic combinations were evaluated in white rats using the oxidative degradation of dl-alanine, glutamic acid, and tyrosine as a gage. Experiments were performed on male rats that received 700 r of Co^{60} gamma radiation. For three days prior to irradiation, a combination of 2 mg of amygdalin, 10 mg of aureomycin, 2 mg of nicotinic acid, and 8 mg of $NaCO_3$ was administered orally. Beginning with the day of irradiation and for 20 days thereafter, the animals were given streptomycin, penicillin, securinine, ascorbic acid, vitamin P, vitamin B_1, vitamin B_6, and a starch solution. Vitamin B_6 was withheld from the 7th to the 15th day postirradiation. Daily sacrifices and studies of oxidative degeneration in liver sections indicated increases in dl-alanine and glutamic acid deamination. Tyrosine oxidation, which normally increases after irradiation, remained constant in the treated group. Therefore, it was concluded that protective and therapeutic measures are collectively more effective than either method used separately. (H.M.G.)

5140 (JPRS-22147) INFLUENCE OF CYSTEINE ON CYTOLOGICAL DAMAGE BY Co^{60} GAMMA RAYS AND PROTONS DURING THE IRRADIATION OF BARLEY SEED. N. I. Nuzhdin, R. L. Dozortseva, and N. S. Samokhvalova. Translated from Zh. Obshch. Biol., 24: 261-75(1963). 20p. (OTS-63-41298)

Cysteine had a protective effect against radioinduced chromosome aberrations and radioinduced changes in mitotic time in barley seeds stored after being brought out of dormancy by artificial means. This was locking in seeds germinated immediately after leaving dormancy. Differences were demonstrated in the response of dormat seeds to Co^{60} γ radiation, protons with an energy of 680 Mev, and neutrons with an average energy of 1 Mev. The frequency of chromosome aberrations depended on the time of seed germination after leaving the dormant state. (C.H.)

5141 (JPRS-22180(Excerpt)) THE PROTECTIVE AND THERAPEUTIC EFFECTS OF THE SOMATOTROPIC HORMONE IN ACUTE RADIATION SICKNESS. S. A. Davydova. Translated from Patol. Fiziol. i Eksperim. Terapiya, 7: No. 4, 64-5(July-Aug. 1963). 4p. (OTS-63-41311(Excerpt))

Steroid hormones failed to exert any protective on therapeutic effect with respect to survival of lethally irradiated rats. (C.H.)

5142 VALUE OF RADIOPROTECTIVE SUBSTANCES IN THE LIGHT OF RECENT RADIOBIOLOGICAL RESEARCH. Z. Zsebok (Medical Radiological Research Unit, Hungarian Academy of Sciences, Budapest). Acta Chir. Acad. Sci. Hung., 3: 21-31(1962).

The possible modes of action of radioprotective substances at the molecular level are discussed with particular reference to Russian literature. Some recent Russian reports on new radioprotective methods are reported. Removal of radionuclides from the body by chelating agents is also discussed. (BBB)

5143 RADIOPROTECTIVE AGENTS. I. SYNTHESIS OF DERIVATIVES OF CYSTEAMINE AND HOMOCYSTEAMINE. G. Tsatsas, C. Sandris, and D. Kontonassios (Univ. of Athens). Bull. Soc. Chim. France, No. 10, 2160-2(Oct. 1963). (In French)

The synthesis of some derivatives of cysteamine and homocysteamine, with the general formulas $RSCH_2CH_2NR'R''$ and $RSCH_2CH_2CH_2NR'R''$, which were to be examined as radioprotective agents, was described. (tr-auth)

5144 INFLUENCE OF DIGLYCYL-GLYCINE ON THE RADIATION SENSITIVITY OF CATALASE. W. Lohmann, A. J. Moss, Jr., W. H. Perkins, and C. F. Fowler (Univ. of Arkansas, Little Rock and Veterans Administration Hospital, Little Rock, Ark.). Experientia, 19: 568-9(1963).

The change of the radiation sensitivity of catalase due to additions of diglycyl-glycine as a radical scavenging agent was investigated spectrophotometrically. The radiation dose was varied between 0 and 2.7×10^6 r. It was found that diglycyl-glycine protects catalase very well. It was concluded that the protective effect can be explained by a radical scavenging mechanism. (M.C.G.)

5145 RADIATION SICKNESS AND ITS CONTROL WITH THIETHYLPERAZINE (TORECAN): A PRELIMINARY EVALUATION. John Donovan (Royal Prince Alfred Hospital, Sydney). Med. J. Australia, 1: 615-?(Apr. 27, 1963).

Thiethylperazine was tested clinically on the grounds that it is a potent antiemetic without significant tranquillizing properties. The 77 patients tested were treated with conventional radiotherapy, a typical dose for carcinoma of the breast being 4000 to 4500 r. Thiethylperazine maleate was used in a standard dosage of one tablet three times a day, in most cases as soon as the patient developed symptoms but in a few cases for prophylaxis when very large abdominal fields were irradiated. Of 31 patients with carcinoma of the breast, 22 obtained complete relief from nausea and vomiting and an additional six obtained partial relief; treatment was ineffective in only three cases. Patients with abdominal and pelvic neoplasms were less responsive to treatment, only about half experiencing complete relief. Altogether, complete or partial relief was obtained by 92% and the treatment was ineffective in 8% of cases. Thiethylperazine was tolerated well and most patients experienced no side-effects. It is concluded that thiethylperazine is an extremely effective drug in the management of radiation sickness, and is possibly the most effective drug now available. (BBB)

5146 EXPLORATION OF ERYTHROPOIETIC FUNCTION BY MEANS OF RADIOACTIVE IRON IN THE RAT IRRADIATED AND TREATED BY BATYL OR SELACHYL ALCOHOL. P. Bassi and A. Dunjic (Institut du Cancer, Louvain, Belg.). Rev. Franc. Etudes Clin. Biol., 7: 187-9(Feb. 1962). (In French)

Erythropoietic activity was followed in rats irradiated and subsequently treated with batyl or selachyl alchol. By means of radioiron (Fe^{59}), the relation between erythropoietic activity and x-ray dose, and the activity as a function of time after a given dose, were studied. Male rats (Institut du Cancer strain L) were exposed to 250-kv x rays at 42 r/min to doses of 100, 250, or 400 r (the 30-day LD_{50} for this strain is 450 r). Batyl or selachyl alcohol was injected subcutaneously at a dose of 2 mg/day in 0.16 ml of peanut oil (controls received oil alone). Injection of Fe^{59} solution (as 0.33 μC $FeCl_3$) was made subcutaneously in all groups of rats on the 3rd, 6th, 9th, and 12th days after irradiation. Erythropoietic activity of irradiated rats decreased, as shown by Fe^{59} incorporation in circulating red cells, with increasing x-ray doses. These alcohols did not conclusively diminish the depressant effect of radiation on erythropoiesis. In all cases, maximum depression of red cell formation occurred on the third postirradiation day, after which it increased in both alcohol-treated and untreated animals. The slight differences found were not statistically significant. These results therefore do not confirm the radioprotective effects of these alcohols, at least with regard to erythropoiesis in the rat, although Edlund and others have demonstrated that they prolong life and enhance leukocyte repletion in irradiated mice. (BBB)

Radiation Hazards and Protection

5147 (JPRS-21975(Del.)(p.13-16)) HAZARDS OF RADIOACTIVE CONTAMINATION OF SURFACES WITH ALPHA-ACTIVE SUBSTANCES. G. M. Parkhomenko. Translated from Gigiena i Sanit., 28: No. 9, 101-3(Sept. 1963).

The relation between atmospheric and surface contamination with alpha-active substances is discussed. Methods of avoiding contamination and normalization procedures are presented. At the present, observance of surface contamination levels adopted in Russia assures reduction of this radiation factor to safe figures. (H.M.G.)

5148 (JPRS-21989(p.5-10)) ACCUMULATION OF RADIOACTIVE ISOTOPES OF STRONTIUM (89-90) AND YTTRIUM (90) BY MIRROR CARP. M. M. Telitchenko. Translated from Rybn. Khozy., No. 5, 40-3(1961).

A study was made of radioactive strontium accumulation in various tissues and organs of mirror carp. Fish were placed in tap water containing carrier-free strontium chloride solutions. The strontium chloride consisted of a mixture of Sr^{90} (80%) and Sr^{89} (20%). Preparations were made of muscles and intermuscular bones, and the radioactivity was determined immediately after the fish were taken out of solution. Results show that strontium–yttrium accumulate in the carps chiefly in the tissues containing a large quantity of calcium (bones, scales). Because the muscles are used as food together with the intermuscular bones, the radioactivity of the edible portion of the fish is considerably increased. Saturation of the organs and tissues of carps with strontium–yttrium occurs after approximately three months, if the contamination of the water body does not exceed the natural strontium concentration in the fresh water (0.1 milligram per liter). At this time the radioactivity of the carp meat approaches the radioactivity of water in the water body. (auth)

5149 FILM DOSIMETRY FOR DETERMINING PERSONNEL EXPOSURE DOSE. M. Mihailovic, N. Fajdiga, and M. V. Mihailovic (Medical Faculty, Ljublijana, Yugoslavia). Acta Med. Iugoslav., 16: 141-50(1962). (In Slovene)

Film-badge dosimeters employing various filters were used to estimate occupational exposure to x and γ radiation among medical and dental workers. The results of 2-yr

(1959-60) measurements are discussed from various aspects, especially as regards the percentage of overexposed persons, dose distribution, and the average dose in various medical specialties. The percentage of the personnel exposed to excessive doses, compared with other countries, was high at the beginning of the survey, but was later decreased. Thus it was reduced from 373 mr in 1959 to 142 mr in 1960. At the latter time there were no groups of persons exposed to increasing doses. The percentage of persons with exposures above the maximum permissible monthly dose (400 mr) was 13% in the first six months after the introduction of the film service, but it decreased to 4% in the latter half of the second year. (BBB)

5150 PROTECTION AGAINST IONIZING RADIATIONS. OUTLINES, DESCRIPTION, AND CONSIDERATIONS OF THE ESTABLISHMENT OF PROGRAMS OF THIS TYPE IN THE AMERICAS. I. M. Lourie and T. E. Shea (Oficina Regional de la Organizacion Mundial de la Salud, Washington, D. C.). Bol. Ofic. Sanit. Panam., 51: 113-18(Aug. 1961).

A program is being developed under the auspices of the World Health Organization for protection from radiation and proper utilization of nuclear energy in the Americas. A program of aid has been developed by the Oficina Sanitaria Panamericana (OSP) consisting of four major points; the registration in each country of all sources of radiation, the teaching of the principles of radiation health physics and the ecological and epidemiological aspects of radiation protection, the promotion of the use of radioisotopes for diagnostic, therapeutic, and research purposes, and the promotion in Latin America of research projects related to radiation and its effects. Research already is in progress on the effects on local populations of excessively high background radiation existing in certain localities in South America. One completed project discussed is the elimination in the Americas of a disease to cattle caused by larvae of the screw-worm fly Callitroga hominivorax, by the sterilization of males using Co^{60} γ rays. Possibilities are suggested for further application of this technique with the object in view of exterminating other diseases in Latin America. The OSP would extend further help, with the provision of consultants for all four points of the program, as well as scholarships for the training of all types of personnel. (BBB)

5151 STRONTIUM-90 IN CHILDREN'S BONES. Brit. Med. J., 1: 698(Mar. 16, 1963).

Measurements of Sr^{90} levels in Great Britain are reviewed and their significance to public health commented upon. Latest reports show that the Sr unit (S.U.) values in bone for 1961 were the same as for 1960 at all age groups from 4-5 years upwards. For younger children and stillborn the 1961, S.U. values were less than for 1960 by about one-fourth. Generally the Sr changes are what would be expected; the amounts of Sr^{90} in milk and food were less in 1961 than 1960 because the last previous atmospheric tests of high-yield atomic weapons were in 1958. In infants and small children some or much of the Sr built into the skeleton during one year is removed during the next year and the newly formed bone salt will contain a smaller proportion of Sr^{90} than before if the levels of intake are less. It is pointed out that fallout may be regarded as a large-scale tracer experiment in man just as, from a meteorological point of view, measurements of atmospheric concentrations of radioactive materials at different heights and distances and times after test explosions have provided new information about large-scale movements of the atmosphere. Monitoring of bone continues to provide direct evidence for the degree of contamination of the body by Sr^{90}, and can be correlated with past measurements of fallout levels in air, rain, milk, and foodstuffs. Recently, large-scale atmospheric nuclear explosions have occurred, and though these may have been cleaner than formerly, it must be expected that Sr^{90} levels in milk and other foodstuffs will rise during the spring and summer of 1963, followed by increases in levels in bone, at least in adults. In 1960 and 1961 the mean level in adults was near 0.3 S.U. The highest mean values in any age group after the large-scale tests in 1958 were 4.2-4.3 S.U. in 6-12-month-old and 1-2-year-old children in 1959. These are $^1/_{500}$ the max permissible level for adult occupational workers, a level which, if sustained for the whole of a working lifetime, carries in the light of present knowledge a negligible probability of severe somatic or genetic injuries. (BBB)

5152 THE CURRENT STATUS OF Sr^{90} CONTAMINATION OF THE HUMAN BODY. O. Pribilla (Universität, Kiel). Deut. Z. Ges. Gerichtl. Med., 51: 516-22(1961). (In German)

Strontium-90 content of milk in Western Germany was determined for 1959-60. Since contamination from fallout is directly related to precipitation, the dry summer of 1959 resulted in a considerable drop of Sr^{90} in milk. Measurements were also made on the food of nondieting patients in hospitals. Milk was found to provide 87% of the Ca requirement of men in this instance. The average value for normal diets, as Sr units (S.U.), was 11 (pC Sr^{90}/g Ca); day to day spreads from 8 to 17 S.U. were observed. The measurements showed an average concentration of 13 pC Sr^{90} per g in Ca ingested. The Sr^{90} measurements were made on the tibia of stillborn and the long bones of infants. The average values over the period 1958-60 were 1.3 pC Sr^{90}/g Ca in the bones of stillborn and 2.0 in 2- to 4-year-old children, with a drop and leveling off in later years. Any increase in Sr^{90} in fetal bones should be carefully watched in the future in relation to a possible increase in stillbirths. (BBB)

5153 PEDIATRIC ROENTGENOLOGY: A SAFE PROCEDURE. W. L. Tanenbaum. J. Am. Osteopath. Assoc., 62: 899-907(June 1963).

A procedure for child fluoroscopy is described that accomplishes minimal dose exposure by using: five mm filtration at the tube window, absorbing the more dangerous soft x rays and improving the quality of the films; kilovoltage up to 150 kvp, which improves penetration and reduces body x-ray absorption; very low ma-sec exposure; use of collimators and cones to localize the rays to the part being examined and avoid unnecessary exposure; and longer distances. It is calculated that observation of these factors makes it possible to take almost 50 films with the same dose once used to take 1-2 films. Other problems in reducing exposure are considered, such as the unnecessary exposure of nurses, technicians, and others holding the child during examination. Problems unique to the interpretation of pediatric radiologic patterns are also extensively discussed, as a possibility of reducing dose by avoiding unnecessary repetitive exposures. (BBB)

5154 REPORT ON RECOMMENDED SAFE PRACTICES IN THE USE OF DIAGNOSTIC X-RAY EQUIPMENT. Duncan G. Kilgour, L. Holland Whitney, Edward J. Schowalter, and Francis X. Worden. J. Occupational Med., 5: 318-20(June 1963).

Recommendations are offered which, if followed, will minimize x-ray exposure to the patient, the x-ray technician, and to personnel located outside of controlled

areas, without sacrificing any of the necessary diagnostic qualities. The generation, characteristics, and health hazards of x rays of diagnostic quality are discussed, and the permissible doses, as recommended in the appropriate National Bureau of Standards Handbook 59, are outlined. (BBB)

5155 THE INCREASE OF RADIOACTIVITY OF WATER PLANTS OF STECHLIN LAKE IN THE YEARS 1961/1962. Roland Glaser (Institut für Angewandte Isotopenforschung and Institute für Medizin und Biologie, Deutschen Akademie der Wissenschaften, Berlin). Limnologica (Berlin), 1: 473-4(1963). (In German)

The beta activity of 9 kinds of water plants were measured in October 1962 and compared with values for the same month in 1960. Results showed that the radioactivity increased by a factor of about 6. (M.C.G.)

5156 STUDIES ON AIR POLLUTION OF ISOTOPE DEPARTMENTS. Laszlo Bozoky (Országos Onkológiai Intezet, Budapest). Magy. Radiol., 14: 228-32(July 1962). (In Hungarian)

The need for a simple, effective, low-cost filter to measure atmospheric radioactive pollution in radiotherapy departments employing isotopes is considered. It was noted that not only may the patients emit substantial γ radiation, but various body discharges, soiled laundry, treatment equipment, storage areas for laundry, and urine specimens present a radiation hazard for hospital personnel. A light, portable sampling and monitoring device was designed that would preclude the use of large built-in filters and their time-consuming operation. The filter was formed from 20 layers of gauze sewn together making a pad of 25-mm dia. This pad filtered out only 50% of the aerosol particles, but its air resistance was 10 times less than conventional types, allowing it to be attached to an ordinary vacuum cleaner. A gas flow meter, installed between the pad and the vacuum cleaner, showed that 1 m^3 air passed through the pad in ~5 min. The filter samples were assayed for radioactivity with a 25-mm dia G-M tube. When the results were checked against a 99.8% effective Soviet-made filter, the 20-layer gauze filter compared favorably. When measurements were made in rooms of patients treated with I^{131}, the samples showed that the activity decreased much more rapidly than the normal 8-day half life of I^{131}. Since there was no other isotope pollution in the area tested, the only explanation for this atmospheric activity is the rapid sublimation of iodine. The first 24 hours following I^{131} administration showed a generally higher air pollution level than had been assumed. Average measurements showed 10^{-9} $\mu C/m^3$ before the rooms were ventilated. The activity measurements were about the same during treatment with I^{131}, P^{32}, Au^{198}, and Na^{24}. Airing the rooms thoroughly three times a day is considered absolutely necessary, as this decreased the atmospheric pollution considerably. (BBB)

5157 X RADIATION IN DENTAL OFFICES IN JEFFERSON COUNTY, ALABAMA. [PART] I. A. H. Wuehrmann, L. R. Manson-Hing, and H. C. Jamison (Univ. of Alabama, Birmingham). Oral Surg., Oral Med., Oral Pathol., 16: 926-36(Aug. 1963).

In addition to use of a questionnaire, the survey included: consultation with dentists and, when necessary, with the dental assistants or hygienists; observation of the physical facilities, protection measures, and darkroom facilities and procedures; and physical measurement of radiation characteristics and protection factors. The survey methods used, particularly for monitoring primary, scattered, and leakage radiation, are described in detail. The survey covered 195 private offices and industrial clinics in which 206 dentists used 222 x-ray machines. Most (82%) dentists previously had either obtained a radiologic safety survey, used some type of personnel monitoring, modified their machines, arranged for the operator and assistant to be shielded, or sought positions at least 6 ft away from the machine when it was operated. Two dentists out of 206 reported noticing changes thought to be related to excessive exposure. Each had had a digit amputated because of pathologic changes. One had held films for patients routinely for two years and the other for 18 years before the changes were noticed. Three others reported having held the films routinely for periods of 1 month, 10 years, and 39 years, but no evidence of pathologic change was noted. Of the 191 darkrooms examined, 74 were judged to have inadequate conditions; ~40% of the dentists use the fastest intraoral film available. Estimates of the weekly roentgenographic work load ranged from 13 to 9020 ma-sec. The estimated annual whole-body exposure of one operator exceeded 2000 mr and nine other operators and/or assistants received annual exposures in excess of 1000 mr; 69% of the operators and assistants received less than 100 mr annually. For three of the machines surveyed, leakage measurements greater than 50000 mr/hr were obtained. One other machine yielded a measurement of 15000 mr/hr. Almost 5% of the machines needed both additional filters and collimating diaphragms to conform to the accepted standards. Another 19% needed additional filters only, and 11% needed collimating diaphragms only. Corrective measures were taken in many cases. (BBB)

5158 INVESTIGATION OF AIR CONTAMINATION IN A NUCLEAR MEDICAL FACILITY. L. Bozoky (Central Inst. for Oncology, Budapest). Radiobiol. Radiotherap., 3: 315-18(1962). (In German)

A light portable device consisting of 20 layers of gauze sewn together to make a pad 25 mm diameter was used to measure air contamination in a medical radioisotope facility. The device filtered out only 50% of the aerosols, but its air resistance was low enough so that it could be used with a vacuum cleaner. Its efficiency was ~50% that of a commercial air filter. One m^3 of air was filtered each five min. Measurements of I^{131} air contamination in a medical radioisotope ward were made before and after ventilation. After ventilation the I^{131} air concentration decreased by one order of magnitude from an average of 1.1×10^{-9} $\mu C/cm^3$. This is close to 10% of the maximum permissible concentration (MPC) for a 40-hr work week. The radioactivity of the samples decreased more rapidly than the half life of I^{131} and indicated that some of the radioisotope evaporated. In view of the frequency that personnel dosimeters have recorded exposure to 50% of the MPC the I^{131} air concentrations may be significant. In other areas (laundry, treatment rooms, and laboratory spaces) the air specific activity of I^{131}, P^{32}, Au^{198}, and Na^{24} varied between 10^{-10} and 10^{-9} $\mu C/cm^3$, but increased sharply in areas where radioactive solutions were contained in open vessels, where surfaces were contaminated, or sterilization procedures were improperly carried out. Thorough ventilation of rooms three times daily is absolutely necessary to reduce radioactivity concentrations of air to safe levels. (BBB)

5159 RADIATION PROTECTION OF PERSONNEL AND PATIENTS IN X-RAY DIAGNOSTIC DEPARTMENTS. E. Hammer-Jacobsen (Rigshospitalet and Radium Center, Copenhagen). Radiography, 27: 210-17(July 1961).

By means of film badges, doses received by nurses and doctors were measured and recorded. Nurses involved in therapy and diagnosis received 444 and 109 mr/yr, respectively, doctors 78 mr, and clerks 6 mr. The maximum permissible dose is 100 mr per week or 5200 mr/yr, and the annual background dose is 100 mr. Means and rules for radioprotection to be employed by radiology department personnel are discussed. (BBB)

5160 RADIATION PROTECTION IN RADIOGRAPHIC LUNG EXAMINATION. Janos Barany (Megyei Kórház, Veszprém, Hungary). Tuberkulozis, 14: 211-5(July 1961). (In Hungarian)

Practical suggestions for lowering patient exposure are offered to radiologists. Maximum permissible radiation doses pertaining to somatic and genetic hazards are given. The measured average gonadal doses of radiation during a 1-min lung examination were 1.8 mr for men, 0.6 mr for women, and 20.0 mr for children aged under 1 year. X-ray pictures may be taken from a distance of 2 m to avoid distortion; in this case, however, direct radiation exposure covers 1 m^2, including the gonads of most patients. A 12-cm dia. cone will expose a circular area of 70-cm dia., leaving the gonads outside the direct irradiation zone. A 40 × 50-cm lead-rubber apron should be worn below the level of the lower ribs for gonadal protection. When a series of exposures is made, a 12-cm cone should be used, and the head, lower half of the body, and half of the lungs should be shielded. The radiation doses reaching the gonads in such series are: without the cone in place, 155 mr for men and 20 mr for women; with the cone, 45 and 12 mr, respectively; with good protective shielding, less than 1 mr. The exposure data available for bronchiography are similar, but no accurate information is presently available. (BBB)

5161 RADIATION HAZARDS IN PERSPECTIVE (THIRD REPORT OF THE EXPERT COMMITTEE ON RADIATION). Lord Adrian. World Health Organ. Tech. Rep. Ser., No. 248, 37p.(1962).

Radiation hazards are reviewed in relation to other hazards to life and health, on a global scale, with emphasis on those attributable to man-made causes. It is suggested that man-made hazards to health must thus be reviewed against the background of known or unknown causes of disease, coextensive with the whole field of medicine. A comparison of hazards from high-level exposures to radiation shows that overwhelmingly more injuries have been caused by toxic agents and accidents in general than by ionizing radiation. Since many more early injuries have been described as resulting from toxic agents than from radiation, this may have been due to more elaborate measures taken to protect workers against radiation hazards (even if correction is made for the numbers of persons at risk). The Committee attempted a quantitative examination of the risks by referring to actual experiences in industrial practice and conditions existing in man's environment. Exposure to low doses of radiation, and the resultant hereditary effects, cancer, and leukemia are discussed. It is concluded that there is a wide gap between the exposure levels resulting in consistent or unequivocally determined toxicological changes in organs, and the natural levels of certain toxic agents in the environment. After radiation exposures, cancer, leukemia, and genetic effects are presumed to occur in small proportions of individuals exposed to levels below those that regularly cause early pathological effects, and there is reason to believe that there is no threshold dose for genetically determined changes. It is, however, stressed that mutations due to natural background radiation can only represent a small fraction of the total number of spontaneous mutations. The Committee recommends that international standards of statistical reporting of effects, damage, disability, and death due to toxic materials and radiation be improved and their use extended to facilitate international comparison; epidemiological and genetic studies of the effects of toxic materials and radiation be promoted; and extensive research be stimulated on their mechanism of action, including their carcinogenic and genetic effects. (BBB)

5162 SELECTIVE FILTRATION: EFFECT ON PATIENT DOSE AND RADIOGRAPHIC QUALITY. Ralph Irvin. X-Ray Technician, 34: 51-7(Sept. 1962).

The use of added filtration to control selectively the patient radiation dose and radiographic quality is considered. Insertion of a filter between the tube port and the patient removes much soft, unwanted radiation that would have been absorbed or scattered within the patient. It is shown that filtration of x-ray photons having reduced penetrating quality affects the shape of the generated beam wave form, as demonstrated radiographically with a high-speed spin top. The film density trace for one half-cycle impulse will become progressively shorter as filtration is added. An equalizing of density from the ends to the trace center will be apparent for large values of filtration. Slight variations in over-all trace density indicate that the beam composition becomes more nearly homogeneous in character. The radiographic effect of filtration is less pronounced for heavier parts because of increased patient absorption. It is proposed that image latitude can be extended greatly at an intermediate kilovoltage by using a 1-mm copper filter. A chest radiograph taken at 85 kvp will appear to have the latitude of one exposed at 120 kvp. The use of 1 mm of copper at 85 kv requires a density correction of 6-fold ma-sec, and at 120 kv produces radiographs of accentuated wide latitude resembling those obtained in the Mev supervoltage range (and requires doubling the ma-sec to maintain the original density). It is not practical to use 1 mm of copper below 120 kv as density compensation becomes drastic and tube loading is approached. Relevant dose data were obtained by measuring the dose at depth in a phantom of tissue density (a pressed-wood phantom with 2 r and 200 mr ionization chambers). Comparison of depth dose curves for several values of filtration revealed the reduction of integral dose by the additional copper filtration. For example, without copper but with 3.5-mm aluminum filtration the ratio of the air to mid-plane (15-cm depth) was 8; with 0.5 mm copper it was reduced to ~4. Studies on colon barium series showed that the visual qualities of radiographs obtained with these values of filtration are diagnostically adequate. Reduction of radiation at ovarian depth was significant. (BBB)

5163 OUTBREAKS OF BROCQ'S NEURODERMATITIS AND MEASUREMENTS OF RADIOACTIVITY AND FALLOUT. K. Schuba and K. Hamann (Universitäts-Klinik und Poliklinik fuer Haut und Geschlechtskrankheiten, Erlangen, Ger.). Z. Haut-Geschlechtskrankh., 32: 333-5(May 1962). (In German)

A previous study suggested that 76.2% of all confirmed new cases of Brocq's neurodermatitis could be related to increased radioactivity in air from weapon tests. In a new study of 88 patients, 51 (56.8%) exhibited exacerbations. In 78.5% of the new outbreaks relatively high activity levels in air were found, while only 21.5% were associated with low levels. In another earlier series of 59 patients, 42 (71.1%) exhibited neurodermatitis. The activity levels in air were high at the outset of 76.2% of these cases, and

low for 23.8%. The results suggest changes in incidence that could be related to differences in peak monthly average values of radioactivity in air, but the question as to whether this relation is more than coincidental will require additional study. (BBB)

5164 RELEASE SYSTEM FOR RADIOGRAPHIC EXPOSURES. Kurt K. Berglund, Axel O. Jacobsson, and Gustav A. Magni (to Jarnhs Elektriska Aktiebolag). U. S. Patent 3,103,590. Sept. 10, 1963. Priority date July 9, 1960, Sweden.

In the release system described, a stray-field generator for producing an intrinsic magnetic, electric, or electromagnetic field is arranged to cooperate with receiving means associated with an x-ray apparatus so as to cause an exposure at the x-ray apparatus to be released by the field thus excited. The receiving device comprises a ferrite rod having a winding adapted to be tuned to the frequency of the stray-field generator by means of a capacitor. It is so arranged that the x-ray apparatus will not be released if the stray-field generator is brought within a predetermined distance of the apparatus. The device enables the operator of the apparatus to remain at such a distance that the danger of exposure to radiation is substantially eliminated. (A.G.W.)

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5165 (TID-7673) PROGRESS IN MEDICAL RADIOISOTOPE SCANNING. Proceedings of a Symposium at the Medical Division of the Oak Ridge Institute of Nuclear Studies, October 22–26, 1962. Ralph M. Kniseley, Gould A. Andrews, and C. Craig Harris, eds. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). [1963]. 539p.

Separate abstracts were prepared for the 21 papers presented. (C.H.)

For abstracts of individual papers see: 5166, 5167, 5168, 5169, 5170, 5171, 5172, 5173, 5174, 5175, 5176, 5177, 5178, 5179, 5180, 5181, 5182, 5183, 5640, 5641, and 5642.

5166 (TID-7673(p.66-104)) DATA RECORDING FOR RADIOISOTOPE SCANNING. C. Craig Harris, P. R. Bell, J. E. Francis, Jr., J. C. Jordan, and M. M. Satterfield (Oak Ridge National Lab., Tenn.).

The development of data-recording systems for use in radioisotope scanning is reviewed. Existing recording methods and devices are reviewed with emphasis on digital recording devices, analog recording devices, and combinations of the two methods. Recent developments in scan recording described include a high-speed dot tapper, a multistylus dot tapper, a photomultidotter, and a halftone matrix printer, and the use of computers as a part of routine scanning equipment. Schematic sketches are included for a rescanner, halftone matrix printer for scan recording, and multidot recorder. (C.H.)

5167 (TID-7673(p.105-10)) DATA PRESENTATION IN RADIOISOTOPE SCANNING: CONTRAST ENHANCEMENT. Merrill A. Bender and Monte Blau (Roswell Park Memorial Inst., Buffalo).

Applications of photoscanning, photorecording, and closed-circuit television systems for contrast enhancement, total recording, and nondestructive, high-contrast playback of data from low-contrast radioisotope scanning are described. (C.H.)

5168 (TID-7673(p.111-31)) SCAN RECORDING IN COLOR. Hirotake Kakehi, Moboru Arimizu, and Guio Uchiyama (Chiba, Japan. Univ. School of Medicine).

The design is described of a color recording device for use in tumor detection by radioisotope scanning. Distribution of the radioactivity in organs can easily be seen in isoresponse regions of color. Illustrative scans of liver and thyroid and a diagram of the essential components of the photorecording scan device are included. (C.H.)

5169 (TID-7673(p.151-7)) THE AUTOFLUOROSCOPE. Merrill A. Bender and Monte Blau (Roswell Park Memorial Inst., Buffalo).

Recent design modifications are described for a γ pinhole camera that improves resolution, efficiency, and high-contrast data presentation in radioisotope scans for tumor localization and organ visualization. Patients are given the established dose of a given radioactive tracer and are scanned in the usual manner. Upon completion of the scan, the patient is transferred to the autofluoroscope, and the study is repeated. Lesions are more readily seen on the autofluorograms than on the scan. Advantages of the autofluoroscope include reduced examination time and the visualization of dynamic processes. The instrument provides high efficiency and the ability simultaneously to detect and record γ rays from all points in the field of interest, so it is possible to use tracer agents with short physical or biological half lives. Examples of clinical applications are cited. (C.H.)

5170 (TID-7673(p.158-70)) PROBLEMS IN RADIOISOTOPE VISUALIZATION. Gordon L. Brownell (Massachusetts. General Hospital. Physics Research Lab., Boston).

Problems in radioisotope visualization during scanning are reviewed. It is pointed out that newer methods of detection give increased sensitivity and provide more information for a given isotope level and scanning time. The development of theoretical and experimental techniques is described that will result in the design of scanning systems that use information more efficiently. (C.H.)

5171 (TID-7673(p.171-89)) SECTION SCANNING FOR IMAGE SEPARATION. David E. Kuhl (Pennsylvania. Univ., Philadelphia).

Methods of image separation in radioisotope section scanning are surveyed. Methods discussed in detail include rectilinear scanning, stereoscopic scanning, section scanning, longitudinal-section scanning, and transverse-section scanning. The potential advantages of each method are compared. The design is described of a stereoscopic scanner that employs body-section principles to separate images of radioactive structures according to their depths in the body. More useful information is obtained from radioisotope studies of the liver, brain, thyroid gland, and other organs, and images of body structures are more clearly defined during section radioisotope scanning. (C.H.)

5172 (TID-7673(p.190-204)) LINEAR SCANNING. D. A. Ross (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

A linear scan is a plot of a person's body radioactivity as distributed along the long axis of the body that shows the total radioactive content of each transverse section of the body as one proceeds from head to foot. An apparatus for linear scanning is described in which two fixed detectors are used and the patient is moved through the detecting gap supported on a slab of 0.5-in. plastic. Applications in clinical studies after the administration of various radioisotopes are described. (C.H.)

5173 (TID-7673(p.205-35)) TOTAL-BODY SCANNING. W. J. Simpson and R. G. Baker [Toronto. Univ.].

The requirements for a whole-body scanning system include rapid scanning rate, large target-to-nontarget ratio, and convenient and interpretable data presentation. Design features are described of a mechanical scanning system that moves the detector head beneath the patient. Results are reported for scans of Fe^{59}, Sr^{85}, and I^{131} following injection into patients with various pathological conditions. (C.H.)

5174 (TID-7673(p.263-70)) MECHANISMS OF ISOTOPE LOCALIZATION. Monte Blau and Merrill A. Bender (Roswell Park Memorial Inst., Buffalo).

The success of any radioisotope scanning procedure depends on the instrumentation and the radioactive agent. It is pointed out that biological behavior is a property of the compound, not the isotope. The development of radiopharmaceuticals for use in tracer studies is reviewed, with emphasis on the development of Hg^{203}-Neohydrin for brain tumor localization and Se^{75}-selenomethionine for pancreas scanning. The rationale that leads to the development of a new agent is discussed. (C.H.)

5175 (TID-7673(p.279-95)) INTRODUCTION TO THYROID SCANNING. Beecher W. Sitterson and Gould A. Andrews (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

Limitations in the interpretation of radioisotope scans in studies of various thyroid disorders are discussed. It is pointed out that uneven distribution of scan marks due to statistical randomness may be interpreted as an abnormality. The clinical usefulness of radioisotope scans in various thyroid diseases is discussed and clinical examples of some factors affecting scan findings are included. (C.H.)

5176 (TID-7673(p.296-311)) THYROID NODULES. Paul Meadows (Hospital of the Good Samaritan, Los Angeles).

Scintillation scanning of I^{131} uptake by the thyroid gland provides a reasonably accurate two-plane pictorial representation of the spatial distribution of radioactivity. It is pointed out that the iodine-concentrating ability of a thyroid nodule declines as the nodule progresses from normal function to degeneration, hemorrhage, cyst formation, and necrosis. The classification of thyroid nodules on the basis of I^{131} concentration is discussed. Results are summarized for a series of 122 clinically single thyroid nodules on which preoperative scintillation scanning was used as a means of classification. It is concluded that the treatment of a single clinical nodule should be guided by the scan appearance, the presence or absence of toxicity, and the clinical condition of the patient. (C.H.)

5177 (TID-7673(p.312-25)) THE USE OF SCANNING IN THYROID CANCER. Gould A. Andrews, Beecher W. Sitterson, and D. A. Ross (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

The usefulness of scanning for the uptake of I^{131} in the diagnosis of thyroid cancer and the location of distant metastases of thyroid cancer is discussed. It is concluded that scanning has limited value in determining possible malignancy of thyroid nodules. The greatest contribution of scanning is in the management of patients with thyroid cancer after most or all of the normal thyroid tissue has been removed. (C.H.)

5178 (TID-7673(p.347-70)) ANATOMY OF THE BRAIN AND BASIC PRINCIPLES OF BRAIN SCANNING. Giovanni Di Chiro (National Institutes of Health, Bethesda, Md.).

The demonstration of craniocerebrovascular structures of brain in the graphic record of radioisotope scans is discussed. Results are described that were obtained with a focusing collimator made of cast gold with 37 channels placed within a 180-lb tungsten shield. A gamma-emitting radioisotope was introduced into the systemic circulation or cerebrospinal fluid cavities and the relative differential activity in the different parts of the endocranium demonstrated by external scanning. It is emphasized that the accurate localization of a brain lesion requires the demonstration of the background structures for satisfactory orientation. Examples are presented in which I^{131}-labeled serum albumin was used as a tracer to demonstrate brain lesions in man. Autoradiodiagrams are included of sections of the frozen head of Macaca mulatta monkeys injected with 50 μC rose bengal into the lumbar sac for the visualization of brain structures by scanning. (C.H.)

5179 (TID-7673(p.371-87)) POSITRON BRAIN SCANNING. Saul Aronow (Massachusetts. General Hospital. Physics Research Lab., Boston).

The use of positron-emitting radioisotopes in brain scanning is discussed. Design features are described for a scanner that employs two detectors and two printing boards so that two pictures are obtained simultaneously. Positron-emitting radioisotopes used include Ga^{68}, F^{18}, Zn^{65}, Cu^{64}, Zr^{89}, I^{124}, As^{72}, As^{74}, and Na^{22}. The As^{74}, injected intravenously as arsenate or arsenite, gave the best scanning results of any of the tracers. Results are evaluated for the diagnosis of brain tumors, abscesses, and other brain lesions. Illustrative scans are included. (C.H.)

5180 (TID-7673(p.388-92)) BRAIN-TUMOR LOCALIZATION WITH GAMMA-EMITTING ISOTOPES. Merrill A. Bender and Monte Blau (Roswell Park Memorial Inst., Buffalo).

Results are summarized on 478 patients with suspected brain lesions scanned 48 hr after the intravenous administration of 5 μC/kg of I^{131}-labeled human serum albumin or Hg^{203}-labeled Neohydrin, using 10 μC/kg and scanned 3 to 5 hr later. An accuracy of 80% is reported for Hg^{203}-labeled Neohydrin scans and 83 to 88% for I^{131}-labeled human serum albumin scans. (C.H.)

5181 (TID-7673(p.405-32)) LIVER SCANNING. James H. Christie and William J. MacIntyre (Western Reserve Univ., Cleveland).

The use of liver scanning after the administration of γ-emitting isotopes for the diagnosis of primary and metastatic tumors, liver abscesses, and to show liver displacement or liver volume or weight is discussed. It is pointed out that there is no increased differential uptake of radioactive compounds by lesions in the liver and that agents must be used that are evenly distributed throughout normal liver tissue with less or no uptake in the lesions of interest. Results are reported from scans after the administration of I^{131}-labeled rose bengal or colloidal Au^{198} to patients with various liver lesions. (C.H.)

5182 (TID-7673(p.433-67)) SCANNING OF THE LIVER, MEDIASTINUM, AND KIDNEY. John G. McAfee (Johns Hopkins Univ., Baltimore. Hospital and Johns Hopkins Univ., Baltimore. School of Medicine).

Instrumentation for scintillation scanning of the liver, mediastinum, and kidney after the administration of γ-emitting isotopes is discussed. Results are reported when Hg^{197}- or Hg^{203}-labeled Chlormerodrin, colloidal Au^{198}, I^{131}-labeled serum albumin, or I^{131}-labeled Hippuran were used as tracers. It is concluded that the combination of Hg^{197}- or Hg^{203}-labeled Chlormerodrin and renal scanning has

great promise as a diagnostic tool for the detection of unilateral renal disease. (C.H.)

5183 (TID-7673(p.468-83)) RADIOISOTOPE SCANNING OF THE SPLEEN. Henry N. Wagner, Jr. (Johns Hopkins Univ., Baltimore. Hospital and Johns Hopkins Univ., Baltimore. School of Medicine.

The ability of the spleen to remove damaged red blood cells from the circulation was used as the basis of a scanning technique for the spleen using reinjected Cr^{51}-labeled damaged red blood cells as a tracer. Results are reported for 109 subjects in which the technique produced a clearly delineated image of the spleen. Clinical applications and the interpretation of splenic scans are discussed. (C.H.)

5184 (UCRL-11033(p.29-40)) THE ALPHA-PARTICLE OR PROTON BEAM IN RADIOSURGERY OF THE PITUITARY GLAND FOR CUSHING'S DISEASE. John A. Linfoot, John H. Lawrence, James L. Born, and Cornelius A. Tobias (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Results are reviewed from studies of pituitary and adrenal function in Cushing's disease. Case histories are presented for 2 patients, one without a demonstrable pituitary tumor and another with an ACTH-secreting pituitary adenoma, who were successfully treated by pituitary irradiation using high-energy α particles from a large accelerator. These penetrating heavy particles provide a more satisfactory form of teletherapy than x-ray or γ-ray sources because larger amounts of ionizing radiation can be delivered safely to the sella turcica. (C.H.)

5185 (UCRL-11033(p.126-9)) SENSITIVITY OF THE POSITRON SCINTILLATION CAMERA FOR DETECTING SIMULATED BRAIN TUMORS. Alexander Gottschalk and Hal O. Anger (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Phantom studies indicated that the positron scintillation camera is a more sensitive instrument for the detection of brain lesions than the conventional positron scanner. It detects lesions one-third to one-fifth as large in volume for each ratio of tumor to brain concentration studied. (auth)

5186 A MODIFIED COBALT 60 APPLICATOR FOR THE TREATMENT OF RETINOBLASTOMA. Bengt H. O. Rosengren and Bjoern Tengroth (Univ. of Gothenburg, Sweden). Acta Radiol., (NS) 1: 305-13(Oct. 1963).

A modified Co^{60} applicator embodying the same fundamental principles as the Stallard-applicators for the treatment of retinoblastoma is described. Five cases are reported. (auth)

5187 INVESTIGATION OF A RADIOACTIVE DRUG (TRA 119) WITH SPECIAL REFERENCE TO AUTORADIOGRAPHIC AND RELATED STUDIES. J. S. Mitchell, E. A. King, D. H. Marrian, and Barbara Chipperfield (Univ. of Cambridge, Eng. and Addenbrooke's Hospital, Cambridge, Eng.). Acta Radiol., (NS) 1: 321-50(Oct. 1963).

Laboratory and clinical investigations were made of the therapeutic possibilities of a radioactive drug containing tritium in very high specific activity, 2-methyl-5,6,7-tritritio-1,4-naphthaquinol bis (disodium phosphate) (TRA 119). Measurements of the specific activity of biopsy and autopsy specimens and autoradiographic studies are discussed in selected cases with special reference to dosimetry. The results provide evidence for some degree of selective concentration of TRA 119 in tumor cells in relation to normal cells in some cases of certain types of malignant disease. (auth)

5188 GONAD DOSIMETRY IN DIAGNOSTIC RADIOLOGY WITH THE HIGH KILOVOLTAGE TECHNIQUE. Hermann Boesche and Sven Roland Kjellberg (Sahlgrenska Sjukhuset, Gothenburg, Sweden). Acta Radiol., (NS) 1: 351-62(Oct. 1963).

Extensive investigations were made on the effects of kilovoltage on gonad dose during diagnostic radiography at kilovoltages of 150 or higher. The superficial, exit, and scatter doses corresponding to the gonad dose were measured in a phantom at voltages ranging from 60 to 190 kv. Proof was obtained that the gonad dose decreases, both at short and long distances, when the tube potential is increased. The gonad dose was considerably higher at radiographic voltages from 60 to 80 kv than in the 100 to 200 kv range. (C.H.)

5189 THE USE OF RADIATION RESPONSE (RR) IN SELECTING THE METHOD OF TREATMENT OF CARCINOMA CERVICIS UTERI. John N. Chesterman (Women's Hospital, Sydney). Australian New Zealand J. Obstet. Gynaecol., 3: 9-12(Mar. 1963).

Attempts were made to determine the choice treatment of cervical squamous carcinoma (surgery, radiation, or surgery with radiation) in Stages I and II. A study of 50 patients showed good results from surgery in patients with poor radiation response (RR) and that the RR, estimated by a precise and uniform technique, will identify those patients who will not respond well to complete radiation therapy. Moreover, it will do this after a first radium application of moderate dosage, at a time when it is still possible to interrupt this therapy. A radiation dose of at least 1000 r at the cervix will be followed by the maximum RR, in a good response, between the 8th and 14th (especially 10th to 12th) days. A poor RR will reach its maximum earlier than a good one, on about the 10th day after radium implantation. When deciding the definition of good RR, it was found that the radiation changes present in a count of 100 cells were seen in more than 70 cells. There is evidence that age, menopause, and hormonal status influence the radiation reaction. If poor RR is more frequently found with high estrogenic activity, young patients treated by radiation should be expected to have a worse survival rate than old. The survival rate is about $\frac{1}{3}$ in the young patient as against $\frac{1}{2}$ in the postmenopausal. A good sensitization response (SR) was, in most cases, followed by good RR after radiation. Of 39 patients with good SR, 34 had good RR after one application of radium. However, this correlation was absent when the SR was poor. Of 41 patients with poor SR, 18 remained poor after radiation and 23 developed good RR. This SR should not be taken alone as a guide to treatment, but all patients should be given the first radium application and the RR assessed. (BBB)

5190 CONTRIBUTION TO MEGAVOLT THERAPY OF MANDIBULAR BLASTOMA BY USE OF ADJUSTABLE ACRYLATE FORMS. E. K. Schmidt and D. Schlegel (Universität, Munich). Deut. Zahnaertzl. Z., 18: 766-84 (1963). (In German)

Several interrelations of the radiation fields produced are discussed. The 2-year survival rate for 41 patients treated with megavolt therapy is ~60% as compared to ~45% in 46 patients treated with conventional radiation therapy. (BBB)

5191 USE OF COLLOIDAL RADIOGOLD FOR PREOPERATIVE INTERSTITIAL PREIRRADIATION OF BREAST CANCERS. J. H. Mueller (Universität, Zurich). Gynaecologia, 156: 36-40(1963). (In German)

Treatment of early breast cancers by infiltration of the

entire parasternal region, the subclavicular area, and the inframammary region with an average of 110 mC of colloidal radiogold dissolved in 140 ml of physiological saline, and given in 12 to 14 injections, has proven advantageous. Fourteen days after this treatment a radical mastectomy is performed, followed by postoperative radiation treatment (200 to 400 kv). In 25 patients treated consistently by this procedure 46% of the beta doses to lymph nodes from Au^{198} amounted to more than 5000 r, and an additional 27% received from 1000 to 5000 r. Taking into account the gamma radiation from this isotope, which probably amounts to 2000 r, it is estimated that at least 70% received a therapeutically effective dose to the lymph nodes. Distribution of the radiogold in the lymph nodes has been confirmed histologically, by autoradiographs, and by neutron activation analysis. In 40 patients previously treated by this procedure, who either had no metastases or only a few in the axillary lymph nodes, no recurrence has been noted in the past 10 years. In three patients who died there was evidence of massive neoplasia (carcinomatous mastitis), extensively axillary lymph node involvement, and latent preoperative hematological symptoms. This procedure is not intended to replace classical methods of treatment, but it represents an important advance in treatment of early breast cancer. (BBB)

5192 FURTHER OBSERVATIONS ON THE USE OF RADIOACTIVE PHOSPHORUS (P^{32}) TO DETERMINE THE VIABILITY OF THE HEAD OF THE FEMUR: CORRELATION OF CLINICAL AND EXPERIMENTAL DATA IN 130 PATIENTS WITH FRACTURES OF THE FEMORAL NECK. H. B. Boyd and R. A. Calandruccio (Univ. of Tennessee, Memphis). J. Bone Joint Surg., 45A: 445-60(Apr. 1963).

Attempts were made to develop a radioisotope method to predict in which femoral heads avascular necrosis will develop. A correlation is made of experimental data and clinical results in 130 patients followed for two years or more. In addition, information gained from 82 autoradiograms of femoral heads removed from 82 other patients is presented to aid in the interpretation and discussion of the clinical data. Experiments on dogs revealed that 2 μC P^{32} per lb of body weight produces a measurable amount of radioactivity in the femoral head and trochanteric region. When the uptake was recorded in the femoral head of dogs, there was a rapid rise in the radioactivity for the first 30 minutes after injection, but after 60 minutes a plateau was established. Uptake was recorded for bone in which the blood supply was partially impaired, as well as in bone with a normal blood supply. In accordance with these findings, patients were given 250 to 300 μC of a buffered solution of P^{32}, and the counts were recorded one hour or more after intravenous injection of the solution. A tube designed for localization of brain tumors was used. The surgical technique for insertion of the probe in the head of the femur is described in detail. Femoral-head specimens from patients with avascular necrosis after fractures of the neck of the femur revealed little or no P^{32} uptake in the region of the bone proved by microscopic examination to be avascular, whereas in the surrounding vascular bone there was uptake. Thus it was shown that if circulation to the femoral head is interrupted there is a lack of uptake for 90 minutes after P^{32} injection. The lack of P^{32} in the femoral head may be interpreted as a sign of nutritional deficiency. Trochanter-to-head ratios obtained from 298 patients showed an incidence of avascular necrosis of 35 to 40%; the ratio of 4.0 was selected, tentatively, as the critical ratio. Autoradiograms of 82 femoral heads obtained from patients with recent fractures (1 day to 8 weeks old) treated initially by insertion of a prosthesis revealed that ~$\frac{1}{3}$ had essentially no uptake of P^{32} except for a small but variable portion in the vicinity of the fovea. Another $\frac{1}{3}$ showed absence of P^{32} in portions of the head, and $\frac{1}{3}$ demonstrated uptake in the entire head. It is concluded that studies of P^{32} uptake are of prognostic value in $\frac{2}{3}$ of patients with displaced fractures of the neck of the femur. (BBB)

5193 THE MECHANISM UNDERLYING THE RESPONSE OF POLYCYTHEMIA RUBRA VERA TO THERAPY WITH RADIOACTIVE PHOSPHORUS. D. L. Weijer, H. E. Duggan, and J. Weijer (Univ. Hospital, Edmonton, Alberta, Can.). J. Can. Assoc. Radiologists, 14: 20-5(Mar. 1963).

Attempts were made to evaluate the conflicting data on the body distribution of P^{32}. Measurements were made at autopsy on tissues of a patient during three weeks after P^{32} injection. The values of μC P^{32}/g are tabulated for 29 specimens assayed, and doses in rad/mC are estimated for various organs. It was calculated that the total dose to the bone compartment from intravenously administered P^{32} would be of the order of 29 rad/mC, and using a selective uptake of 2:1, the dose to the bone marrow would be of the order of 13 rad/mC administered. Another study with P^{32} and S^{35} was designed to separate ionization effects in human blood cell cultures from transmutation effects, by using one isotope that is incorporated into the cells and one that is not incorporated. Radiation damage was measured from the incidence of binucleate cells in slides made from cultured human leukocytes after four days' incubation. Both decay of DNA-incorporated P^{32} and β radiation will increase the frequency of this condition when determined in vitro. A burst of mitotic activity occurred in all cultures between 65–72 hr after initiation of the experiment, followed by an increase in the number of binucleate cells. At 97 hr the ratio of the number of binucleates in the P^{32} cultures to the number of the S^{35} cultures was ~2:1, while the numbers in the control cultures were 3–4 times fewer than in the S^{35} cultures. Radioisotope incorporation assays showed that the cellular uptake of P^{32} after 94 hr of incubation was 4% of the added isotope, whereas no S^{35} was incorporated during the same period. To explain the high biological efficiency of P^{32}, it is necessary to take into account its uptake by genetically important compounds (DNA, RNA, free nucleotides). It is concluded that the recoiling S nucleus gives rise to DNA breaks and subsequent chromosomal aberrations. The chromosomal defects do not always affect the viability of the cell, but do impair chromosome disjunction during division, and hence render the cell inactive. Thus, studies with mitotically active leukocytes illustrate the transmutation effects of DNA-incorporated P^{32}; 4% of the added P^{32} was incorporated after one nuclear division, but only 20% of the incorporated isotope had decayed over that period. Consequently, the final extent of damage resulting from decay alone (transmutation effect) must be in excess of the damage due to β irradiation. It is suggested that in the same way erythropoiesis in vivo will be affected by the presence of P^{32}, since erythroid elements are constantly replenished from a primitive or stem-cell pool and go through a series of divisions to maturation prior to their emergence as circulating erythrocytes. It is proposed that the response of polycythemia vera to therapy with P^{32} is due to two different radiobiologic effects: ionization caused by β radiation and chemical instability of genetic material after transmutation of the incorporated P^{32}. In polycythemic patients, this latter effect is probably

the main mechanism underlying the inactivation of the hematopoietic tissue by P^{32}. (BBB)

5194 RE-EVALUATION AND APPLICATION OF INTERPOSED NONMETALLIC FILTERS IN DIAGNOSTIC RADIOLOGY. John J. Douglas (Clark-Holder Clinic, LaGrange, Ga.). J. Med. Assoc. Georgia, 50: 541-3(Nov. 1961).

A simple filter prepared from modeling clay is described as an adjunct in obtaining more critical detail and information with a minimum of radiation exposure to the patient. The filter, by absorbing the softer x rays, allows for increased penetration of more energetic rays in certain anatomic regions, allowing better contrast between structures. Characteristics of the described filter are: simplicity, adaptability, availability, reliability, low cost, and efficiency. (BBB)

5195 GAMMA-RAY AND POSITRON SCINTILLATION CAMERA. Hal O. Anger (Lawrence Radiation Lab., Berkeley). Nucleonics, 21: 56-9(Oct. 1963). (UCRL-10933)

The principles of operation of the gamma-ray scintillation camera are discussed. Three different methods of collimation are described: pinhole collimation, multiaperture collimation, and positron camera collimation. Image recording is discussed briefly. Several clinical applications of the camera are described. (D.L.C.)

5196 PREAMPLIFIERS FOR CRYSTALLINE DETECTORS WITH SMALL CAPACITY. E. A. Afanaseva and E. A. Konorova (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 110-11(Sept.-Oct. 1963). (In Russian)

A preamplifier system with a cathode follower in the entrance, for work with crystalline particle detectors of small capacity, is described. The noise level for the operating region of 200–900 kHz is reduced at the amplifier entrance and, expressed in the number of electron-hole pairs, is nearly 1100 for an entrance capacity of 1.2 nf (or 150 μv). The amplification coefficient is 16. (tr-auth)

5197 INDICATIONS, DOSAGES, AND EFFECTS OF THERAPY WITH INTERNAL USE OF RADIOIODINE, RADIOGOLD, AND RADIOPHOSPHORUS. H. A. E. Schmidt (Universität, Freiburg i. B.). Radiobiol. Radiotherap., 3: 103-20(1962). (In German)

Therapeutic uses of I^{131}, Au^{198}, and P^{32} are discussed with emphasis on optimal dose evaluation. For thyroid ablation with I^{131} in angina pectoris or cardiac insufficiency the individual dosage should be singly determined to avoid induction of myxedema. For a single treatment the dose may range between 30000 and 40000 rep and for single, fractionated doses; the range is usually between 10000 and 20000 rep. Positive results are obtained in over half the cases. Dosages for euthyroid goiter are 15000 to 20000 rep given singly each 10 weeks until clinical remission is observed, but treatment of malignant thyroid growths varies with their iodine retention capability and dosages range from 50 to 200 mC. Side effects from I^{131} treatment are relatively infrequent if dosage is controlled relative to clinical status. Intravenous Au^{198} therapy is used for micronodular liver and spleen tumors, lymphosarcomata, and leukemia at dosages up to 60 mC. Intrapleural Au^{198} therapy is carried out with 50 to 150 mC and intraperitoneal treatment with up to 225 mC. For intratumoral treatment of the genitourinary tract up to 170 mC or 2 mC/g tumor tissue is used. Up to 50% favorable response is obtained with this and with intracavitary treatment. Radiophosphorus is used for treatment of leukemia in dosages of 1 to 5 mC/week, and for treatment of polycythemia vera at a rate near 100 μC/g body weight. Repetition of the dosage depends on evaluation of subsequent clinical status. Frequency of leukemia in 172 P^{32}-treated polycythemic patients has been reported as 3%, but this frequency was 17% in 163 patients treated by other means. (BBB)

5198 POSSIBILITIES OF SHIELDING OF SENSITIVE PORTIONS OF THE EYE DURING BETA IRRADIATION (Sr^{90}). Rolf Vollmar (Humboldt Universität, Berlin). Radiobiol. Radiotherap., 3: 133-42(1962). (In German)

A small adhesive glass capsule with a removable 0.5-mm thick layer of Pb is used for protection of the sensitive portions of the eye (cornea, lens, etc.) during Sr^{90} β irradiation. The capsule need not be fitted optically to the eye surface. Bremstrahlung from the Pb amounts to less than 1% of the 500-r single dose applied during 25 sec with a 40 mC/cm^2 applicator. Radiation losses between the applicator and the eye surface are minimal. The method has been used to reduce vascular invasion of the cornea and cloudiness of transplants, marginal ulcerations in senile degeneration, chronic lymphocytic conjunctival hyperplasia, growing conjunctival nevus in children, and conjunctival melanoma. A combined treatment of the conjunctival bulba and tarsi was used for diseased conditions such as chronic lymphocytic conjunctival hyperplasia or laminar melanosis of the conjunctiva. Large capsules with portions of the edges removed are utilized for segmental irradiation of pterygium to avoid damage and appearance of late radiation effects in other portions of the eye. A large assortment of eye capsules is necessary to provide for the wide variety of sizes of individual conjunctiva. Use of eye capsules avoids damage to the lens that may otherwise receive as much as 10% of the surface beta dosage. This could bring about cataract formation as a later radiation injury. (BBB)

5199 LOCAL TREATMENT OF RETINAL TUMORS WITH RADON. A. G. Fingerhut (Harbor General Hospital, Torrance, Calif.). Radiology, 81: 1003-7(Dec. 1963).

Three cases of malignant tumor of the retina were treated by Rn plaques surgically applied to the posterior portion of the bulb (7 applications). This method is advocated when enucleation is either contraindicated or refused by the patient. The advantage of utilizing a plaque rather than direct application of radioactive sources is described in detail. (auth)

5200 SIDE-EFFECTS OF COMBINED RADIATION AND CHEMOTHERAPY IN THE TREATMENT OF MALIGNANT TUMORS. Richard E. Ottoman, Edward A. Langdon, Donald B. Rochlin, and Charles R. Smart (Univ. of California, Los Angeles). Radiology, 81: 1014-17(Dec. 1963).

A study was made of the effects of 5-fluorouracil (FU) and x irradiation, separately and in combination, upon multiple metastatic tumors within individual patients. Fourteen cases satisfied the criteria for a controlled study. In 4, the effects of irradiation alone were greater than the combination, in 4 the effects were equal, and in 6 the effects of irradiation were less than those of combination therapy. This study failed to demonstrate a significant alteration in the tumor response by the addition of FU to x irradiation. Four instances of unusual reactions in previously irradiated skin were noted following FU administration. (auth)

5201 A FAST TISSUE-DOSAGE SYSTEM FOR 200-kv ARC THERAPY. James E. Turner (Veterans Administra-

tion Research Hospital, Chicago). Radiology, 81: 1028-37 (Dec. 1963).

A simple, rapid, and economical dosimetry method for arc therapy was evolved by the application of dosage charts described by Stern to a polar format of dose points described by Tsien. Rotation is imitated by assuming entry of stationary beams at 10° intervals. Special dosage data charts were prepared for 16 field sizes at hvl 1.5-mm Cu and target-axis-distance 60 cm. The method enables a technician with a desk calculator to compute water-equivalent tissue doses at off-axis points in the entire plane of rotation at the rate of 40 to 60 sec per point. With this information, the radiologist can shape effective dose zones to surround the tumor and avoid radiosensitive normal structures, with placement of dose maxima where they will be most effective. Doses calculated by this method agree with those calculated or measured by other investigators to within 5%, on the average. (auth)

5202 LEUKEMIA, MULTIPLE MYELOMA, AND APLASTIC ANEMIA IN AMERICAN RADIOLOGISTS. E. B. Lewis (California Inst. of Tech., Pasadena). Science, 142: 1492-4(Dec. 15, 1963).

A survey of 425 death certificates of radiologists dying between the ages of 35 and 74 during the years 1948 to 1961 revealed a statistically highly significant excess of deaths from leukemia, multiple myeloma, and aplastic anemia. That this excess is due to radiation exposure (or to some factor acting in a similar manner), rather than to an artifact of diagnosis is suggested by the absence of deaths ascribed to chronic lymphatic leukemia. (auth)

5203 DOSE DISTRIBUTION IN THE IRRADIATION OF INHOMOGENEOUS MEDIA WITH FAST ELECTRONS. Gerhard Breitling and Karl-Heinz Vogel (Universität, Tubingen, Ger.). Strahlentherapie, 122: 321-40(Nov. 1963). (In German)

The dose distribution during irradiation of nonhomogeneous media with fast electrons was investigated using phantom measurements. The problem with the use of electron accelerators with very high energies, especially for the use of fast electrons in deep therapy, is discussed. (auth)

5204 CALCULATION OF DOSE DISTRIBUTION IN TANGENTIAL PENDULUM IRRADIATION WITH Co^{60}. Guenter Schoknecht (Städt. Aguste-Viktoria-Krankenhauses, Berlin). Strahlentherapie, 122: 341-8(Nov. 1963). (In German)

A method for calculating the dose distribution during pendulum irradiation, described previously was extended for tangential pendulum irradiation using the dose distribution of stationary radiation direction. The geometric conditions necessary for the calculation are discussed. An example of the calculation procedure is given. There is good agreement between calculated and experimental dose values especially in the area of the maximum dose. There is no need to calculate fixed field isodoses in the case of oblique radiation direction. (auth)

5205 CLEANING AND TRANSPORTING DEVICE FOR A RADIOACTIVE SOURCE. William B. King. U. S. Patent 3,102,958. Sept. 3, 1963. Filed Aug. 27, 1958.

A wheeled device for cleaning and transporting a radioactive source for therapeutic use is described. A shielded vault on the wheeled chassis contains a rack on which the source may be placed. Underneath the rack is mounted a washing impeller driven by a shaft extending through the wall of the vault to a clutch, motor, and pump assembly. A sequence control device provides a washing and rinsing cycle for cleansing the source and rendering it sterile after use. A device is also provided to indicate the presence or absence of the source before the vault is opened. (A.G.W.)

5206 RADIATION BEAM SHAPING DEVICE. Eugene P. Thomas, Charles H. Jennings, and Charles R. Griffith (to Westinghouse Electric Corp.). U. S. Patent 3,114,043. Dec. 10, 1963. Filed Jan. 28, 1960.

A device is designed for collimating radiation for selective exposure in radiotherapy. The device comprises a rectangular box for holding precut lead sheets to give the desired collimation, and a ring for fastening to a radiation source. (D.L.C.)

CHEMISTRY

General

5207 (SC-DC-3503) RADIOCHEMICAL STUDIES: PART I. ISOTOPIC EXCHANGE REACTIONS. SOLVENT EFFECTS. PART II. PREPARATION AND PROPERTIES OF CARRIER-FREE AMALGAMS. Hans L. Hamester (Sandia Corp., Albuquerque, N. Mex.). 1963. Contract [AT(29-1)-789]. 259p.

Thesis submitted to Univ. of New Mexico, Albuquerque.

I. The work described is concerned with the kinetics of an S_N2 reaction, the isotopic exchange reaction between iodide ions and p-nitrobenzyl iodide, carried out in an aprotic solvent, acetone, in the presence of various substituted phenols and anisole. This reaction was carried out at concentrations of potassium iodide low enough to ensure the absence of ion pairs. The tendency of substituted phenols to reduce the observed second-order rate constant was correlated with the ability of each compound to form a hydrogen bond with the iodide ion. As expected, the anisole had no noticeable effect on the rate. The experimental data were analyzed by a method which makes allowances for the presence of small and constant amounts of hydroxylic impurities. II. The Adsorptive and Radiocolloidal Properties of Carrier-Free Silver. This section deals primarily with the removal of carrier-free silver-110m from dilute nitric acid and aqueous solutions of miscellaneous common reagents by adsorption on Pyrex glass. Adsorption is believed to occur via a relatively rapid cation-exchange process followed by a slow diffusion step. Radiocolloids were detected by high-speed centrifugation in 0.0001 molar to 0.01 molar nitric acid. The work reported suggests that these radiocolloids are produced as a result of adsorption of silver by siliceous and organic dust particles, and lends support to that school which attributes radiocolloid formation to the adsorption of tracer materials by ubiquitous dust particles rather than the intrinsic agglomeration of the radioactive species. III. The Preparation and Properties of Carrier-Free Silver Amalgams. Carrier-free silver-110m amalgams were prepared by chemical deposition of silver from aqueous solutions. The amalgams proved to be homogeneous and stable in air over long periods of time. The validity of the equilibrium constant expression at extremely low concentrations was checked. The distribution of silver-110m activity between mercury and aqueous acid solutions of mercurous perchlorate was determined for total silver concentrations varying from carrier-free (less than 2×10^{-10} molal) to 2×10^{-4} molal. A plot of ln (molality Ag in the amalgam phase)/(molality Ag^+ in the aqueous phase) vs ln (molality Hg_2^{2+} in the aqueous phase) for solutions of constant ionic strengths yielded a straight line with a slope of −0.51, in satisfactory agreement with the predicted slope of −0.500, for mercurous perchlorate concentrations of 1.05×10^{-1} to 5.27×10^{-6} molal. IV. The Preparation and Properties of Carrier-Free Lead Amalgams. Carrier-free lead-212 amalgams prepared by both electrodeposition from aqueous solutions and by collection of the active deposit in a vacuum, proved to be quite unstable in air. Electrodeposition resulted in amalgams containing lead-212 in at least two chemical forms. (auth)

5208 BULLETIN OF THE CHEMICAL SOCIETY. Milos Mladenovic, ed. Translation of Glasnik Hemiskog Drustva, Beograd, 27: No. 2-3, (1962). 125p. $1.75(OTS). OTS-62-11757

Thirteen papers are included on the following topics: ultrasound decontamination of I^{131}, mass transfer onto anodically oxidized Al, various analytic techniques, reactions of hexanitrocobaltates with amino acids, chemical investigations of wheat, enzymatic degradation of organophosphorus compounds in animal plasma and tissues, and a temperature scale based on the kinetic theory of gases. The paper dealing with ultrasound decontamination of I^{131} was previously abstracted in NSA. (D.L.C.)

5209 PREPARATION OF URANIUM MONOSULFIDE. Kazuhiko Yoshioka (to U. S. Atomic Energy Commission). U. S. Patent 3,119,653. Jan. 28, 1964.

A process is given for preparing uranium monosulfide from uranium tetrafluoride dissolved in molten alkali metal chloride. A hydrogen–hydrogen sulfide gas mixture passed through the solution precipitates uranium monosulfide. (AEC)

Analytical Procedures

5210 (CONF-157-5) DETERMINATION OF HAFNIUM AND RARE EARTHS IN ALUMINUM ALLOYS. John H. Sikes, Marven A. Wade, and Stanley S. Yamamura (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). [1959]. Contract AT(10-1)-205. 9p.

From American Chemical Society Northwest Regional Meeting, Bellingham, Wash., June 1963.

Procedures are described for both a titrimetric and a gravimetric determination of hafnium in aluminum–hafnium alloys. The gravimetric procedure is used if the hafnium is to be recovered; otherwise, the titrimetric procedure is preferred. The sample is dissolved in aqua regia. Any undissolved hafnium is taken into solution via pyrosulfate fusion. The hafnium is separated from the aluminum and contaminants in the aluminum by precipitation as the mandelate. In the gravimetric procedure the hafnium mandelate is heated to the oxide, then weighed. In the titrimetric procedure the mandelate is destroyed with nitric, sulfuric, and perchloric acids. The hafnium then is determined by adding a measured excess of EDTA and back titrating the excess EDTA with a standard bismuth solution to a xylenol orange end point. (auth)

5211 (CRRD-1171) MEASUREMENT OF SMALL CONCENTRATIONS OF ARGON-41 IN AIR. G. Cowper, B. Banville, and A. S. Coveart (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oct. 1963. 7p. (AECL-1868)

Knowledge of the dispersal of radioactive aerosols from a reactor stack is necessary in order to assess the hazard to those in the environment following a reactor accident. The measurement of argon-41 in air, which is produced by neutron activation of atmospheric argon in reactor coolant channels, is a convenient means of determining dilution factors. The apparatus described used a detector consisting of thin plastic scintillators and is capable of detecting argon concentrations as small as 0.02×10^{-12} C/ml in the presence of background gamma radiation of up to 0.15 mr/hr. (auth)

5212 (EUR-438.f) DÉTERMINATION RAPIDE DU CÉSIUM 137 DES RETOMBÉES RADIOACTIVES AU MOYEN DE PHOSPHOMOLYBDATE D'AMMONIUM. (Rapid Deter-

mination of Cesium-137 in Radioactive Fall-Out by Means of Ammonium Phosphomolybdate). E. Van der Stricht (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 16p.

A new rapid method of cesium-137 determination is described. Based on the utilization of thin layers of ammonium phosphomolybdate, this method has been developed for the measurement of cesium-137 in samples such as milk, vegetation, soils, fish, water, and radioactive dust; it should be possible to extend it to other types of sample without difficulty. By this means cesium-137 can be obtained directly, in a single operation, in a form which enables the β measurement to be made. The respective advantages of the β and γ measurements are discussed, and the use of statistical methods in the planning of radioactivity monitoring measurements is illustrated. (auth)

5213 (K-1542) MEASURING U^{235} BY MASS SPECTROMETER COMPARISON TO U^{233} INTERNAL STANDARDS. O. C. Smitherman (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 16, 1963. Contract W-7405-eng-26. 7p.

A mass-spectrometric method for measuring the U^{235} isotopic concentration of uranium in uranium hexafluoride by comparison to that of an internal standard of U^{233} was developed. The method is particularly useful for uranium with less than 0.1 wt % U^{235}, which is difficult to measure precisely by the usual methods. Standards containing approximately 0.03 wt % U^{235} were analyzed by this method to a precision of ±0.27% of the value at the 95% confidence level. (auth)

5214 (PG-Report-496) ANALYTICAL METHOD FOR THE SPECTROGRAPHIC DETERMINATION OF BERYLLIUM IN AIR AND SWAB SAMPLES BY THE ROTATING DISC TECHNIQUE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 36p.

The sample, when in the form of a filter paper, containing either airborne dust or contamination from the dry swabbing of a surface, is wet-oxidized using a sulfuric/nitric acid mixture. Scandium is added to act as an internal standard and the solution is spectrographed by the rotating disc technique using a medium spectrograph with either a direct reading attachment or photographic recording. When the sample is in the form of an acid bubbler solution (hydrochloric or sulfuric) an aliquot is taken and evaporated to low bulk. Sulfuric acid is added if the sample is hydrochloric acid. Scandium is added as internal standard and the solution is spectrographed in the same way as the wet oxidized filter paper samples. The method is applicable to air samples obtained by drawing air through a Whatman filter paper under controlled flow conditions. The method is applicable to swab samples obtained by the dry swabbing of suspected surfaces with a filter paper. The method is applicable to 5M sulfuric acid solutions or 5.5M hydrochloric acid solutions which have been used in bubblers to trap the beryllium in air bubbled through them. Beryllium can be determined over a concentration range of 0.03 to 50 μg in the solution presented for spectrographing. With photographic recording, the results show negligible bias with the precision (3 × sigma) calculated for single exposures of ±60% at the 0.03 μg level, ±42% at the 1 μg level, and ±24% at the 20 μg level. With direct reading, individual results at the 0.1 μg level have a precision (3 × sigma) of ±60% with a positive bias of 8%. The precision improves at higher beryllium concentrations, being ±22% at the 0.25 μg level and ±18% at the 0.5 and 1 μg level. The bias at these higher concentrations is <1%. (auth)

5215 (TID-19813) NITRATE ANALYSIS OF THORIA SOLS BY ULTRA-VIOLET ABSORPTION. Technical Report No. XXI. Byong D. Chun and Milton E. Wadsworth (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Oct. 15, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2176. 13p.

The absorption of ultraviolet light by nitric acid and nitrates was previously shown. Its characteristic maximum absorption peak at 3000 Å wavelength was used in the study of nitrates in thoria sols. The relation between absorbency at 3000 Å and concentration of the nitrates supports Beer's Law, independently of the kinds of positive ions present. The total decrease of initial light intensity was due to two kinds of light absorption, conservative absorption and consumptive absorption. In the visible light region, general Tyndall absorption (conservative absorption) obeyed the Rayleigh Law and in the 3000 Å region of the ultraviolet spectrum additivity was demonstrated for conservative absorption and consumptive absorption. Using this additivity property, pure absorbency due to nitrate was obtained by which the concentration of the nitrates in thoria gel was determined. (auth)

5216 (TID-19818) SODIUM RESISTIVITY METER LOOP. Summary Report, October 1963. (Atomic Power Development Associates, Inc., Detroit). Contract [AT (11-1)-865]. 9p.

Test runs were made on the Blake Rhometer and the variable-orifice plugging meter which were designed to determine the contamination level of various impurities in a controlled sodium loop environment. Injections of Na_2O, Na_2CO_3, CO, and CO_2 were used in the test runs, and plugging meter values and rhometer readings are given. (D.L.C.)

5217 SCATTERING AND ABSORPTION OF RADIOACTIVE RADIATION UTILIZED IN THE ANALYTICAL AND OPERATIONAL CONTROLS [IN PHARMACEUTICAL PROCEDURES]. Pavel Schiller (Faculty of Pharmacy, Bratislava). Acta Fac. Pharm. Bohemoslov., 7: 7-61 (1962). (In German)

Theoretical aspects of β scattering, its use in analyzing various elements in drug preparations, techniques employed, and instrumentation for this procedure are extensively discussed. Methods are described for determination of six elements in 18 kinds of medicaments and compounds in both solid and liquid form, or as emulsions and ointments. The elements determined were as follows: Bi in mixtures of bismuth subgallate and gallic acid, bismuth subnitrate, and MgO; Hg in an aqueous solutions of $HgCl_2$; Au in the injection preparation Chrysothios; Ag in aqueous solutions of $AgNO_3$ and colloidal Ag; I in aqueous solutions of KI and in the injection preparations Biligrafin, Intrajodin, Jodantox, and Dionosil; and Br in aqueous solutions of Na and K bromates. The analytical procedures are of unusual rapidity in determining these elements, since they do not require any preliminary treatment of the sample, such as solution or compression, or any other operations during the determination, such as precipitation, filtering, weighing. The whole analytical process takes only a few minutes and leaves the sample in its original condition. Accuracy of the determination may be increased according to need by raising the activity of the source of radioactivity or by lengthening the time of measurement. Methods based on β scattering also make possible quick, continuous, and automatic control of raw materials or semifinished and finished products in individual stages of pharmaceutical process. Immediate automatic intervention

in the production process is facilitated, when an automatic control device is combined with regulating elements. A method for continual level measurement in various operations is also described, whereby regulation is made possible on the basis of the absorption of β radiation. An apparatus was constructed for automatic level measurement which is applicable also in high-pressure and high-temperature systems, or in the highly viscous, corrosive, and explosive media. The measuring accuracy of ±1 mm, not achieved with the other level-measuring systems, meets the requirements of controlling the amount of a medium in hoppers by means of computers. (BBB)

5218 METHODS OF NUCLEAR PHYSICS IN PHYSIOLOGY. P. Marmier (Eidgenossische Technische Hochschule, Zurich). Arch. Ges. Physiol., 273: 111-19(1961). (In German)

Some advantages and limitations of activation analysis and reaction analysis are discussed. Activation analysis can be utilized to detect the O^{18} concentration in as little as 10^{-6} g of oxygen. Examples of this procedure in studies of muscle physiology are presented. Reaction analysis has, in comparison to activation analysis, the advantages that it does not require the formation of an isotope with a favorable half time and often it permits the simultaneous estimation of several isotopes that may be present in the target. Radioisotopes formed in reaction analysis may be identified readily and rapidly by their spectra, but the sensitivity of the method may be reduced by bremsstrahlung from protons or neutron activation of the detector or associated equipment. A third method of analysis depends on recoil effects, where the magnitude of the recoil energies of elastically scattered particles are proportional to the ratio of particle masses. The method permits evaluation of the type and number of particles scattered. The methods described, alone or in combination, are and will be of much value for study of life processes. (BBB)

5219 GAMMA SPECTROMETRIC DETERMINATION OF HAFNIUM IN ZIRCONIUM. Bohumil Zitnansky and Imrich Sebestian (Vyzkumny Ustav Zvarcsky, Bratislava). Chem. Listy, 57: 518-26(1963). (In Czech)

A method for determining Hf in Zr is described that utilizes radioactivation and spectrometric scintillation γ analysis. The Hf concentration is determined from measurements of the photopeaks of the 229.5- and 136.2-kev levels in the γ spectra of Hf^{175}, Hf^{181}, and Zr^{95}. From the Hf activity measured below the 229.5-kev level the pulses from $Zr^{95} + Nb^{95}$ are subtracted, these being recorded simultaneously with the Hf^{175} and Hf^{181} pulses. As a standard for the determination of Hf in Zr by this method it is necessary to simultaneously activate pure Zr and the unknown specimen under the same conditions, since data from pure Zr is needed for determination of the conversion constant. Development of this method for comparative determinations is described. For this purpose it is sufficient to compare a sample containing known Zr and Hf quantities with the activities of the unknown specimens, the conversion constant of Zr not being necessary. (BBB)

5220 THERMAL NEUTRON ACTIVATION DETERMINATION OF TRACE ELEMENTS IN WATERS AND OTHER LIQUIDS BY FORMATION OF SHORT-LIVED ISOTOPES. J. Selz, W. Haerdi, and D. Monnier (Université, Geneva). Chimia (Aarau), 17: 354-5(Nov. 1963). (In French)

Thermal neutron activation was used to determine the concentration of Na, Mg, and Cl in the water of Leman lake and of Na in blood and urine. The steps in the determination are the evaporation, irradiation of a fraction of the residue, irradiation of a standard, and gamma spectroscopy. The values found for the lake water were 1.4 to 1.6 mg/l for Cl, 4.4 to 4.6 mg/l for Mg, and 2.0 to 2.1 mg/l for sodium. 270 mg of Na/100 ml of blood and 220 mg/50 ml of urine were also detected. These are in good agreement with the values in the literature. The sensitivity of the method is indicated. (J.S.R.)

5221 SEPARATION AND DETERMINATION OF MICROGRAM AMOUNTS OF SCANDIUM AND THORIUM. Che-ming Ni and Shu-chuan Liang. Chung Kuo K'o Hsueh, 12: 1238-9(1963).

5,7-Dichloro-8-quinolinol in chloroform was used to extract thorium from aqueous solution (pH 3.2 to 3.4), without extraction of scandium. An ethanolic solution of xylenol orange was added directly to the organic layer, which was then washed once with water. The absorbence was measured at 540 mμ. The aqueous layer containing scandium was adjusted to pH 5 to 5.5 with urotropin and extracted again with dichloroquinolinol in chloroform solution. The scandium in the organic layer was determined directly by adding an ethanolic solution of xylenol orange, and the absorbence was measured at 530 mμ. Iron(III) was extracted with the thorium and was thus separated from scandium. Color intensity of the scandium complex was stable over a 3-hr period; color intensity of thorium was stable for 1 hr. By plotting optical density versus amount of scandium (0 to 15 μg) or thorium (0 to 60 μg), straight lines through the origin could be obtained; the slope of the scandium line was greater than that of the thorium line. (OTS)

5222 TRIHYDROXYFLUORONES AS PHOTOMETRIC REAGENTS FOR NIOBIUM. V. A. Nazarenko and G. Ya. Yagnyatinskaya (Odessa Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 9, 1218-22(1963). (In Ukrainian)

Sixteen derivatives of 2, 3, 7-trihydroxy-6-fluorone were studied as reagents for the photometric determination of niobium. Niobium reacts with trihydroxyfluorones in acid media. The absorption spectra of the niobium complexes are displaced more to the longwave region in phosphoric acid than in sulfuric or hydrochloric acid solutions. The ratio of Nb to reagents in the complexes is 1:2. Colored solutions of complexes stabilized by gelatine follow Beer's law. All of the investigated compounds can be used as reagents for niobium but the best are 9-(o-nitrophenyl)-trihydroxylfluorone (ϵ of the complex 5.06×10^4 for 515 mμ) and 9-(β-hydroxy-α-naphthyl)-trihydrofluorone (ϵ of the complex 5.17×10^4 for 510 mμ). (auth)

5223 DETERMINATION BY THERMAL NEUTRON ACTIVATION OF SHORT-LIVED ISOTOPES. Denys Monnier (Universite, Geneva). Ind. At. 7: Nos. 9-10, 83-91(1963). (In French)

The activation determination of short-lived isotopes has numerous advantages. It is often very sensitive and very rapid. When it is possible to avoid the formation of interfering radioisotopes, the activity is measured directly on the sample and the determination lasts only a few minutes. If the spurious radioactivity cannot be avoided, radiochemical separations (precipitation, ion exchange, extraction, etc.) are necessary. These separations should be very rapid, but the loss, which can be exactly determined, does not compromise the determination. (tr-auth)

5224 NEUTRON ACTIVATION OF ELEMENTS AND THE NON-DESTRUCTIVE GAMMA SPECTROMETRIC

DETERMINATION OF SHORT-LIVED RADIOISOTOPES. Werner Haerdi (Universite, Geneva). Ind. At. 7: Nos. 9-10, 93-106(1963). (In French)

The activation analysis of elements based on the formation of short-lived radioisotopes is evolving rapidly. Because of its precision, sensitivity, flexibility, and rapidity of execution, the method offers new analytical possibilities. Some factors that affect the activation and detection of gamma radiation are studied. The variety of neutron sources and instrumentation for the measurement of gamma activity demands a careful choice of conditions. (tr-auth)

5225 USE OF CASTAING MICROPROBE FOR THE ELEMENT AND STRUCTURAL MICROANALYSIS OF SINTERED ALUMINIUM. R. Theisen (EURATOM, Ispra, Italy). Mem. Sci. Rev. Met., 60: No. 3, 189-94(Mar. 1963). (Eur 386.f). (In French)

The CAMECA microprobe automatic scanner makes it possible to obtain pictures of the scanned area (square of 300 μ maximum side) showing the distribution of the chemical element for the spectrometer is set. By adjustment of the discriminator thresholds, it is possible to isolate aluminum, aluminum oxide, and the ironrich inclusions in sintered aluminum (SAP and FRITTOXAL). By giving an agreed color to each of these pictures, a single color image is obtained by superimposing the matrices. The composition of the ferrous inclusions in sintered aluminum, as well as of the oxidation products occurring on corrosion in the organic liquid OM_2 and in water was determined (thin film technique). A process for the automatic counting of the number and the vol % concentration of the inclusions was evolved, defining two important features of the material: mechanical deformation strength and corrosion behavior. The diffusion speed of silver in sintered aluminum, which is important for bonding by means of silver film diffusion, was investigated with a view to developing a welding technique for sintered aluminum. (auth)

5226 DETERMINATION OF NIOBIUM, ZIRCONIUM AND YTTRIUM BY THE X-RAY SPECTRUM METHOD BY MEANS OF AN EXTERNAL STANDARD. V. E. Mamaev. Met. i Khim. Prom. Kazakhstana, Nauchn.-Tekhn. Sb., No. 4, 76-80(1961).

External standards intended for the plotting of calibration curves were made with fillers whose mass coefficient of absorption $\mu_{mi\circ}$ was selected as equal to the coefficient of the oxide (Nb_2O_5, ZrO_2, or Y_2O_3) introduced into them. Composition of fillers: 48.7% SiO_2 + 51.3% FS_2 for Nb_2O_5; 46.4% SiO_2 + 53.6% FeS_2 for ZrO_2; 72.7% SiO_2 + 27.3% FeS_2 for Y_2O_3. Part of the sample was used for determination of its mass coefficient of absorption μ_{mix} on the line of the element being determined, then the intensity of the analytical line K_α in the sample was determined, a correction was introduced for background, and the value of C_i was determined from the calibration curves. The concentration sought was calculated from the formula: $C_x = (\mu_{mix}/\mu_{mi\circ})C$. Without the introduction of corrections it is possible to determine Y_2O_3 in the presence of Nb_2O_5 and ZrO_2 up to 30%, ZrO_2 in the presence of Y_2O_3 and Nb_2O_5 up to 5%, and Nb_2O_5 in the presence of ZrO_2 and Y_2O_3 up to 5% of each. The mean error for the determination is 6–7%. (Referativnyy Zhurnal. Khimiya, No. 12, 1962)

5227 LOW-LEVEL ASSAY OF IODINE-131 IN BIOCHEMICAL RESEARCH. D. F. Barnaby and L. G. Plaskett (University Coll. Hospital, London and Univ. of Edinburgh). Nature, 200: 950-4(Dec. 7, 1963).

Problems in low-level assay of I^{131} were examined as they occurred in the examination of iodine metabolism. Details are provided of a counting system, which proved its value in the scanning of low-activity paper chromatograms. The results that were obtained in analyzing the iodine compounds of extrathyroidal tissues are discussed. The need for low-level counting is discussed. The relative importance of low background and high efficiency in the choice of counting system is emphasized. (M.C.G.)

5228 DETERMINATION OF MICROTRACE AMOUNTS OF MANGANESE IN NITRIC AND HYDROCHLORIC ACIDS BY NEUTRON ACTIVATION ANALYSIS. Wieslaw Otwinowski and Zygmunt Allina. Nukleonika, 8: 411-19(1963). (In Polish)

A description is given of a method for determining microtrace amounts of manganese in nitric and hydrochloric acids by neutron activation analysis. A total residue of evaporation of 10 ccm of acid was irradiated in nuclear reactor in flux of 10^{13} neutrons per second per sq. cm. The radiochemical variant of this method was used and the beta activity of Mn^{56} was measured. The lower limit of determination was $5 \cdot 10^{-11}$ g per cc. Coefficient of variation of the mean result (based on 3 independent determinations) was not greater than 30%. (auth)

5229 THE FEASIBILITY OF THE FAST NEUTRON ACTIVATION ANALYSIS TO THE COPPER CONTENT DETERMINATION IN COPPER ORES. Ludwik Gorski (Inst. of Radioisotopes Techniques, Krakow). Nukleonika, 8: 421-4(1963).

From a comparison of the nuclear properties of Cu, it is shown that fast neutron activation results in a gamma activity which is 7 times as great as that from thermal neutron activation and which is due to positron annihilation and therefore can be registered on a coincidence spectrometer. Since the threshold energy of the $Cu^{63}(n,2n)$ reaction is 12 Mev, a D-T neutron source must be used. The interferences in Low Silesia ore are examined. In an estimate of the sensitivity of the proposed method, the activation of 5 g ore containing 2% Cu in a flux of 10^7 fast $n/cm^2/sec$ for 2 min was found to give $\sim 3 \times 10^3$ coincidences/min. The activity due to oxygen can be eliminated by delaying measurement by 1 min after activation, and the time needed for the determination is estimated to be 5 min. (D.L.C.)

5230 MIXED PEROXY-COMPLEXES OF TITANIUM, NIOBIUM AND TANTALUM. III. CHELATOMETRIC TITRATION OF NIOBIUM^V. Erik Lassner (Metallwerk Plansee, AG, Reutte, Tirol). Talanta, 10: 1229-33(1963). (In German)

A chelatometric method for the titration of Nb(v), using nitrilotriacetic acid is described. This forms a 1:1 complex with the peroxy-Nb(v) ion. NTA is added in excess, and the excess is back-titrated with Cu solution at pH 5.0 to 5.5 using the metallofluorescent indicator, Methylcalcein, under uv illumination. The reproducibility, for amounts of 4.56 to 23.68 mg of Nb is 0.07 mg of Nb. N-Hydroxyethylethylenediamine-N,N',N'-triacetic acid forms a similar 1:1 complex, and can be used instead of NTA, but with little advantage. (auth)

5231 THE DETERMINATION OF RADIUM-226 IN HUMAN BONE. Naomi A. Hallden, Isabel M. Fisenne, and John H. Harley (U. S. Atomic Energy Commission, New York). Talanta, 10: 1223-7(Dec. 1963).

A simple procedure is described for preparing 10-g samples of bone ash for measurement of Ra^{226} by the Rn^{222} emanation technique. In this case, the radon is measured in 2-liter ion chambers, but scintillation chambers could be used. Coprecipitation of Ra^{226} with $BaSO_4$ gives separation from bulk constituents, and the final precipitate is

soluble in a few ml of 30% EDTA. Chemical recovery is measured with Ba^{133} tracer. (auth)

5232 DETERMINATION OF SILVER IN LEAD BY NEUTRON-ACTIVATION ANALYSIS. F. Adams (Ghent Univ.), J. Hoste, and A. Speecke. Talanta, 10: 1243-9(Dec. 1963).

Submicrogram amounts of silver were determined in lead by neutron-activation analysis. The activity of the Ag^{110} isotope was measured by following the decay of the 0.66-Mev gamma ray. Reproducibility was generally better than 10%. The smallest amount of silver determined was approximately 0.02 μg. The analyses were completed within 15 min. (auth)

5233 ANALYTICAL CHEMISTRY 1962. The Proceedings of the International Symposium held at Birmingham University (U.K.), April 1962. Philip W. West, A. M. G. MacDonald, and T. S. West, eds. New York, Elsevier Publishing Company, 1963. 420p.

Sixty-four articles are included; separate abstracts were prepared for 14. One article on computer-coupled automatic activation analysis was previously abstracted in NSA. The 49 articles not abstracted include information on spot tests and qualitative analysis, semiquantitative spot test methods, organic reagents and their applications, electrochemical methods of analysis, radiochemical methods of analysis, optical methods of analysis, separation processes, and titrimetric analysis. (P.C.H.)

For abstracts of individual papers see: 5234, 5235, 5236, 5237, 5238, 5239, 5240, 5241, 5242, 5243, 5244, 5245, 5246, and 5247.

5234 SPOT TESTS ON PAPER OF TRANSURANIUM ELEMENTS. CHARACTERIZATION OF DIFFERENT DEGREES OF OXIDATION OF NEPTUNIUM AND PLUTONIUM. Frank Clanet (Commissariat à l'Energie Atomique, Paris). p.28-38 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963. (In French)

Spot tests on paper of transuranium elements with 36 organic or inorganic reagents usually used in paper chromatography were studied for different valence states of Np and Pu. The sensitivities and the colors obtained are reported. (auth)

5235 CHRONOAUTORADIOGRAPHY BY THE RING-OVEN TECHNIQUE. L. J. Ottendorfer (Technische Hochschule, Vienna). p.100-5 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

A method is described for the determination of radioactive matter using chronoautoradiography by the ring-oven technique. (P.C.H.)

5236 PRECIPITATION PROCESSES WITH METAL ORGANIC CHELATES. Louis Gordon, Norton Haberman, Orville E. Hileman, Jr., and Paul Ellefsen (Case Inst. of Tech., Cleveland). p.145-51 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

The development of new precipitation from homogeneous solution (PFHS) methods, thermal decomposition of metal chelates, and kinetics and mechanism studies of precipitation processes are discussed. (P.C.H.)

5237 EXTRACTION OF NIOBIUM, TANTALUM, TITANIUM, ZIRCONIUM AND VANADIUM. N-BENZOYL-N-PHENYLHYDROXYL AMINATES FROM SULPHURIC ACID SOLUTIONS. I. P. Alimarin and O. M. Petrukhin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). p.152-5 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

Conditions are described for the extraction of Nb, Ta, Ti, Zr, and V from H_2SO_4 solutions using N-benzoyl-N-phenylhydroxylaminates. It is noted that for all the considered elements the interaction with BPHA in H_2SO_4 solutions is observed beyond the limits of extraction of the reagent itself, in 28-30 N acid solutions. The normalities of H_2SO_4 at which 50% of the reagent and of the complex metal compounds are extracted are: 22 N for BPHA; 27 N for Nb and Zr; 25 N for V; and 23.2 N for Ti. (P.C.H.)

5238 THE SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM IN THE PRESENCE OF TANTALUM AND ASSOCIATED ELEMENTS. R. J. Magee and I. Martin (Queen's Univ., Belfast). p.193-9 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

Methods were investigated for the rapid colorimetric determination of Nb in the presence of Ta and associated elements. Two approaches were made. In the first, the behavior of Nb and Ta with different reductants was investigated. In the second a study of ammine-type complexes was carried out. A procedure is described for the best determination of Nb. (P.C.H.)

5239 ELECTROCHEMICAL ANALYSIS IN ATOMIC ENERGY. G. W. C. Milner (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.255-62 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

Developments of electrochemical methods for the determination of Fe, Pu, Np, and U are reported. Methods for the determination of each element are discussed separately. (P.C.H.)

5240 SOME RECENT WORK USING SPECIFIC AND SENSITIVE NUCLEAR METHODS. A. A. Smales (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.263-8 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

Nuclear and radiochemical properties for the purpose of sensitive and specific identification and measurements of Te, Ge, Bi, Zr, and Cd are discussed. Consideration is given to an (n,γ) reaction followed by radioactive decay of the product to give a radioactive daughter (n,γ); β^-, and how the additional properties available are useful in specific identification. (P.C.H.)

5241 THE USE OF BISMUTH RADIONUCLIDES IN ANALYSIS. D. T. Lewis, D. I. Coomber, and J. R. W. Kerr (Laboratory of the Government Chemist, London). p.274-80 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

For the monitoring of natural waters for radon content, a bismuth precipitation procedure, which gives a rapid and reasonably accurate method for radon concentrations extending from 100 to 10000-20000 pc/l, is described. Where extreme sensitivity is required, in the 1-10 pc/l range, other methods must be employed; but since the U. S. maximum tolerance figure is of the order of 2000 pc/l, the present simple monitoring technique will undoubtedly have useful applications where large numbers of water samples must be analyzed. (P.C.H.)

5242 EXTENSION OF SENSITIVITY IN TRACE ELEMENT ANALYSIS. George H. Morrison (Cornell Univ., Ithaca, N. Y.). p.320-7 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

A review is presented on the trace analysis of elements in solid materials by activation analysis, emission spectroscopy, and spark-source mass spectroscopy. Special attention is given to extension of sensitivity in the methods. (P.C.H.)

5243 HIGH-MOLECULAR-WEIGHT AMINES VERSATILE MODERN EXTRACTANTS. Fletcher L. Moore (Oak Ridge National Lab., Tenn.). p.345-55 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

Separation procedures using high-molecular-weight amines are described. A general survey of applications is included. (P.C.H.)

5244 METAL-AMINE COMPLEXES IN ION EXCHANGE. IV. SEPARATION OF AMINES BY LIGAND EXCHANGE. H. F. Walton and J. J. Latterell (Univ. of Colorado, Boulder). p.356-60 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

A survey of ligand exchange distributions and the use of the new technique in elution chromatography is presented. Aromatic amines, pyridine and benzylamine, were determined in the presence of ammonia by uv absorption in the region of 250 mμ. The diamines were determined by titration (the accompanying ammonia could be removed by boiling) or by measuring the light absorption of solutions containing copper or nickel ions; even small proportions of diamine shifted the color from grey-blue to violet-blue. Piperidine was determined photometrically by a modification of the method that uses the reaction of secondary amines with carbon disulfide and a cupric salt. Ammonia interfered badly and was removed in part by extracting the amine with 2-ethylhexanol. Hydrazine was titrated with bromate. Silver was titrated with thiocyanate, and nickel was detected and determined by precipitation with dimethylglyoxime. Results of the determinations are discussed. (P.C.H.)

5245 THE ANALYTICAL APPLICATIONS OF REDOX REACTIONS IN HYDROFLUORIC ACID. J. B. Headridge and M. S. Taylor (Univ. of Sheffield, Eng.). p.382-7 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

The reduction of Nb(V), W(VI), and Mo(VI) in hydrofluoric acid solutions was studied. With regard to the titration of Nb(III), W(III), and Mo(III) it is noted that the reduced species are not stable in acid solution even in the absence of oxygen. They are oxidized with varying speeds by hydrogen ion. (P.C.H.)

5246 ON THE EXISTENCE OF THE URANYL ION. Clément Duval (Centre National de la Recherche Scientifique, Paris). p.388-93 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963. (In French)

Experimental data, obtained by measurements of the number of ions, by electrolysis, electrophoresis, microanalytical methods, infrared absorption spectrography on solids, solutions, and deuteration, are provided to show that the accepted formula of uranyl chloride is incorrect. The proposed formula is $(UO_3H)_2[UCl_6(OH)_2]$. Doubt is cast on the existence of uranyl ions. (auth)

5247 THE PREPARATION OF DEUTERIUM PERCHLORATE, DEUTERIUM SULFATE AND DEUTERIUM IODATE. G. Frederick Smith and Harvey Diehl (Univ. of Illinois, Urbana and Iowa State Univ., Ames). p.394-6 of "Analytical Chemistry 1962." New York, Elsevier Publishing Company, 1963.

Methods are described for the preparation of deuterium perchlorate ($DClO_4$), deuterium sulfate (D_2SO_4), and deuterium iodate (DIO_3). (P.C.H.)

5248 IMPROVEMENTS IN OR RELATING TO THE DETECTION OF FISSION PRODUCTS. Murray Vincent Wilson (to Plessey Co. Ltd.). British Patent 937,663. Sept. 25, 1963. Filed July 27, 1959.

A method and apparatus are described for detecting fission products carried in a gaseous phase and measuring their quantity by electrostatically precipitating the daughter products of the gaseous fission product materials onto an inactive liquid surface in the presence of a gas phase and then transferring the liquid medium to an activity counting device shielded from the active gas phase. The liquid surface may be in the form of charged drops, charged jets, or a surface film covering a suitably shaped electrode. In one preferred form of the apparatus the electrode is a dished porous plate with a central bore through which the liquid is led into a shielded counting chamber. The liquid is delayed in this chamber for a suitable period, and secondary decay of the precipitated activity is measured. Proportional counters, scintillation counters, or an assembly of Geiger tubes may be used for activity measurement. (A.G.W.)

5249 X-RAY ANALYZING APPARATUS WHEREIN TWO COMPARATIVE DETECTOR CHANNELS HAVE DIFFERENT ABSORPTION VERSUS FREQUENCY CHARACTERISTICS. John Edward Bigelow (to General Electric Co.). U. S. Patent 3,100,261. Aug. 6, 1963. Filed July 29, 1960.

Simple and inexpensive x-ray analyzing equipment is described, which provides an indication of the amount of a given element in a specimen relative to the amount of another element in the specimen. X radiation impinges upon the specimen to be examined, which, in turn emits characteristic radiation. The emitted radiation then enters two separate channels, the output of one of which has an amplitude vs. frequency characteristic including a maximum corresponding to a given frequency of interest. The other channel has a similar characteristic with a maximum displaced from that of the first channel. Each channel comprises an aperture, filter, and ion chamber detector. The parameters of the filters, apertures, and detectors of the two channels are chosen relative to the known content of the specimen such that the output of the two channels when balanced against each other provides a null reading when the specimen contains the two elements of interest in the desired proportion. The outputs of the two channels are of opposing polarity such that the polarity of the balanced signal, if other than a null reading, indicates which of the two elements is in excess. When the equipment is so arranged that one channel receives radiation from the specimen and the other channel receives it directly from the radiation source, the output signal constitutes an indication of the absolute quantity of the element under investigation. (A.G.W.)

5250 METHODS AND APPARATUS FOR MEASURING AND TESTING. Kennard H. Morganstern (to Nuclear Corp. of America, Inc.). U. S. Patent 3,100,840. Aug. 13, 1963. Filed Apr. 14, 1958.

A method and apparatus for using high neutron cross section materials as tracers or labels is proposed. A high thermal neutron cross section material, which may preferably be one of the rare earth metals or one of their compounds, is added to a material having a low neutron cross section. Thereafter the presence of the rare earth material is detected by passing the substance between a neutron source and a neutron detector or a γ-ray detector that detects γ rays resulting from neutron absorption. By this method a tracing or labeling function can be achieved without introducing radioactivity throughout an entire

system. Possible applications include marking the interface between two batches of oil in a pipe line, determining thickness of materials or coatings, or permanently labeling a manufacturer's product. (A.G.W.)

5251 DEVICE FOR SELECTIVELY DETECTING THE OCCURRENCE OF FISSION PRODUCTS IN GASES. Jean Goupil and André Roguin (to Commissariat a l'Energie Atomique). U. S. Patent 3,105,146. Sept. 24, 1963. Priority date Dec. 5, 1957, France.

The device described is based on the theory that the difference between two activity measurements, performed on the same radioactive gas mass immediately after the passage of short-lived fission products and again after a period of time equal to several half lives of the short-lived fission products and shorter than the half lives of the long-lived fission products, is representative of the activity of the short-lived fission products. The device includes a detection chamber, means for controlling the flow of gas in the chamber, detecting means for determining the radioactivity in the chamber, and means for comparing the results of two subsequent radioactivity determinations. The device is intended for use in the effluents of gas-cooled nuclear reactors and particle accelerators. (A.G.W.)

Inorganic and Physical Chemistry

5252 (IS-678) THE CRYSTAL STRUCTURE OF SODIUM HYDROGEN FLUORIDE. James Edward Benson and D. R. Fitzwater (Ames Lab., Ames, Iowa). May 1963. Contract W-7405-eng-82. 63p.

The structure of $NaHF_2$ was reinvestigated with the primary interest being to determine, as accurately as possible, the F-F distance in this crystal. The distance was found to be 2.273 ± 0.004 Å and is the same, within experimental error, as that found in ammonium and potassium bifluoride. The $NaHF_2$ crystal was found to contain a feature that will allow it to be used as a check on any method that is used to correct the intensity of a reflection for white radiation streaking. The necessity for making such a correction is illustrated, and one method, that of D. R. Fitzwater, was examined and was found to give the intensity of a peak due to white radiation streaking to within 10% of the intensity actually observed. (auth)

5253 (NP-13337) IZUCHENIE OBRAZOVANIYA ANOMAL'NYKH SMESHAKNYKH KRISTALLOV CaF_2-CuF_3 AND CaF_2-YF_3 PRI KRISTALIZATSII FTORIDA KALTSIYA IZ RASPLAVA. (Formation of Anomalous Mixed Crystals CaF_2-CeF_3 and $CaF-YF_3$ During Calcium Fluoride Crystallization from Melts). K. G. Myakishev and V. P. Klokman (U.S.S.R. Soviet Ministrov. Godudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 21p.

Solubility limits of cerium and yttrium fluorides in the CaF_2-NaF system were determined at 864°C. It was shown that cerium and yttrium fluorides precipitate with calcium fluoride (which crystallizes without melting) without a lower boundary of miscibility. The absolute crystallization coefficient of cerium fluoride is higher than yttrium fluoride. Crystallization of cerium and yttrium fluorides depends strongly on the temperature. An increase of temperature from 864 to 1015°C increased the crystallization coefficient several times. (R.V.J.)

5254 (SC-DC-3564) ENERGY MIGRATION IN RARE EARTH COMPLEXES. John Jerome Freeman (Sandia Corp., Albuquerque, N. Mex.). 1963. Contract [AT(29-1)-789]. 219p.

Thesis submitted to Univ. of New Mexico, Albuquerque.

Complexes of trivalent samarium, europium, terbium, and dysprosium were prepared for investigations of the luminescence properties of complexed rare earth ions. Rare earth chelates derived from benzoylacetone, dibenzoylmethane, and acetylacetone; rare earth chlorides solvated with water and deuterium oxide; and rare earth oxides dissolved in sodium metaphosphate glasses were synthesized for these studies. Initial investigations were conducted on the β-diketone chelates dissolved in organic glasses at 77°K. The luminescence spectra of the samples, arising from excitation by ultraviolet light, are reported, and groups of spectral lines are given J-J assignments. The luminescence decays of the rare earth ion emissions, arising from radiative transitions originating at the lowest resonance level of the ions, were measured. The decay curves were analyzed statistically, and a lower limit of 5×10^5 sec^{-1} is reported for the rate constant associated with intramolecular energy transfer. From a consideration of the rate of energy transfer and the magnitude of the molecular phosphorescence decay times of the chelates, it is concluded that intramolecular energy transfer cannot originate at the same level from which phosphorescence occurs. Intramolecular energy transfer rate constants for transfer of energy to the ions from higher levels of the triplet energy systems in these compounds are discussed. The visible absorption spectra of solutions of rare earth chelates and rare earth chlorides are presented and analyzed. Rare earth ion radiative transition probabilities, calculated from the weak ion absorption bands, are reported. It is shown that the increased luminescence decay times of the chelated rare earth ions as compared to the solvated rare earth ions must be due to a decrease in quenching of the ion states, not to a decrease in the radiative transition probabilities. The luminescence investigations were also carried out on microcrystalline chelates, crystalline solvated chlorides, and metaphosphate glasses. The emission spectra are presented and J-J assignments are made. Measurements of spectral lines arising from vibronic coupling of chelated rare earth ions are given. The luminescence decay curves of the complexes are reported, and decay times calculated from the curves are tabulated. For a few of the samples, the temperature dependencies of the luminescences are also reported. Quite significant differences were found in the luminescence intensities and decay times of rare earth ions in different environments. Possible mechanisms for quenching of rare earth ion states are presented, and it is concluded that the variations of the luminescence properties of the ions are due to variations in vibronic quenching efficiency. The nature of the vibronic quenching in each of the different rare earth complex systems is discussed. Secondary environmental effects on the rare earth ion luminescences are considered, and it is shown that factors such as the nature of the solvent and the method of sample preparation must be considered in any quantitative discussion of the luminescence properties. The origins of the discrepancies among the luminescence decay times reported by other authors are also considered. (auth)

5255 (TID-19811) PHOTOCHEMICAL AND THERMAL NITRATING PROPERTIES. Final Report. (Colorado. Univ., Boulder). Contract AT(11-1)-753. 130p.

A reaction calorimeter utilizing thermoelectric heat pumping under isothermal conditions was designed. The calorimeter, which may be considered as a modification

of the Tian-Calvet devices, differs in the following respects: the heat of reaction is totally compensated by thermoelectric cooling, the temperature fluctuates about the temperature of the thermostat so that relatively large heat effects can be measured under nearly isothermal conditions, precise measurements of temperature differentials and specific heats is unnecessary, semiconductors were used rather than metallic thermocouples for thermoelectric cooling, and the cooling rate is automatically adjusted by an external control circuit as the rate of heat flow from the calorimeter block changes. An attempt was made to nitrate the "3" position of acenaphthene with the uranium complex $UO_2(NO_3)_2N_2O_4 \cdot H_2O$. Although the reaction was run under a great variety of temperature and composition conditions, the predominant product in all reactions was 5-nitroacenaphthene. The uranyl salt of squaric acid was prepared and its properties studied. The kinetics and mechanism of the reaction of $UO_2(NO_3)_2 \cdot N_2O_4 \cdot H_2O$ with 2,4 dichloroaniline in alcoholic solutions were determined. (M.C.G.)

5256 (TID-19814) AGING OF COLLOIDAL THORIA. Technical Report No. XXII. B. D. Chun, M. E. Wadsworth, and F. A. Olson (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Oct. 15, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2176. 36p.

The effects of various parameters on particle growth rates of colloidal thoria prepared from a nitrate medium was studied by means of turbidity, electron microscopy, and x-ray diffraction techniques. The x-ray results showed little if any growth of the basic 50 Å diameter crystallites making up the colloidal particles. The turbidity results showed that (1) particle growth apparently occurred due to aggregation of crystallites, (2) growth rate was a direct function of temperature up to 80°C and decreased rapidly thereafter, (3) growth rate was inversely dependent on thoria concentration in the range 0.01 to 0.2 molar, and (4) the rate was also inversely dependent on electrolyte addition, except that addition of $Th(NO_3)_4$ at greater than about equimolal amounts caused immediate precipitation. Conclusions are drawn as to the nature of the growth process based upon these findings. Although growth studies of the thoria prepared from the calcined oxalate were not conducted it was observed that apparently the basic crystallites were much larger and the resulting particles were very inhomogeneous in size as contrasted to the fair size uniformity of the thoria prepared from the nitrate. (auth)

5257 (AEC-tr-6146) HYDRATES OF URANIC ANHYDRIDE AND HEAT OF FORMATION OF URANYL NITRATE. R. de Forcrand. Translated from Compt. Rend., 156: 1954-8(1913). 7p.

The heat of formation of anhydrous uranyl nitrate was determined. The preparation of uranic anhydride and its hydrates is described. The heat of oxidation of uranium, the heat of formation of the hydrates of uranic acid, and the heat of neutralization of this acid and its hydrates with nitric acid had to be determined. (M.C.G.)

5258 (AI-Trans-16) THE SPECIFIC HEAT OF CESIUM NITRATE IN THE 50-450°C TEMPERATURE INTERVAL, AS WELL AS ITS TRANSITION AND MELTING HEAT. Arvo Mustajoki. Translated by Anthony Cornell (Atomics International., Div. of North American Aviation, Inc., Canoga Park, Calif., from Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 7, (1957). 12p.

The values of specific heat of $CsNO_3$ in the 50 to 450°C temperature interval were measured with the Moser calorimeter. The measurements were made both on heating and on cooling. In the first mentioned case the accuracy of the values of the specific heat is ±0.5, and in the latter ±1.5%. The transition point, the transition heat, and the transition entropy of $CsNO_3$ were determined. The resulting values were 151.5°C, 0.893 ± 0.06 kcal/mole, and 2.10 ± 0.02 cal/mole degrees. Likewise, the melting point, the heat of fusion, and the fusion entropy were determined, the values of which were 405.5°C, 3.37 ± 0.03 kcal/mole, and 4.97 ± 0.04 cal/mole degrees. (auth)

5259 ON THE STABILITY OF THE ACETATE AND GLYCOLATE COMPLEXES OF TRIVALENT CURIUM. Ingmar Grenthe (Univ. of Lund, Sweden). Acta Chem. Scand., 17: 1814-15(1963).

The stability constants β_1 for the curium acetate and glycolate complexes were found to be somewhat larger than the β_1-values for the corresponding americium complexes and much larger than those for the gadolinum acetate and glycolate systems. The difference in stability between the lanthanide complex and its corresponding actinide complex is most pronounced for the glycolate systems. (P.C.H.)

5260 CHROMOTROPIC ACID AND ITS ZIRCONYL AND THORIUM COMPLEXES. Michiaki Sakaguchi, Atsunobu Mizote, Haruo Miyata, and Kyoji Toei (Okayama Univ., Tsushima, Japan). Bull. Chem. Soc. Japan, 36: 885-8 (Aug. 1963).

The composition of zirconyl and Th chromotropate was determined by the continuous-variation and the mole-ratio methods, while the stability constants of the zirconyl and Th complexes were measured from their absorbances. The data are tabulated. (P.C.H.)

5261 THE ION-EXCHANGE EQUILIBRIUM BETWEEN CESIUM AND PHENOL-SULFONIC-ACID-TYPE CATION EXCHANGE RESIN. Hiroyuki Tsubota (National Inst. of Radiological Sciences, Chiba, Japan). Bull. Chem. Soc. Japan, 36: 1038-43(Aug. 1963).

In the $Cs^+ - (NH_4^+ + NH_3)$ exchange system, the distribution coefficients of cesium can be approximately expressed by: $\log K_d = pH - 1.6 \log [NH_4^+ + NH_3] - 8.8$. In the $Cs^+ - Na^+$ and $Cs^+ - K^+$ exchange systems, the distribution coefficients of cesium can be expressed with a good approximation by: $\log K_d = 0.25 \log [OH^-] - 0.90 \log [Na^+] + 2.4$ and $\log K_d = 0.25 \log [OH^-] - 0.90 \log [K^+] + 1.7$. In the $Cs^+ - NH_4^+$ exchange system, the distribution coefficients of cesium can be expressed by: $\log K_d = -1.1 \log [NH_4^+] + 0.62$. The specific adsorption of cesium by the active phenolic groups is observed when the pH value of the outer solution is above 12, and high selectivity is obtained above 13 for the $Cs^+ - Na^+$ exchange system. For the $Cs^+ - (NH_4^+ + NH_3)$ exchange system, the specific adsorption of cesium is observed above pH 11, and an extremely high selectivity can be obtained when the total concentration of the outer solution is below 1 mol/l. (P.C.H.)

5262 VARIATION OF THE ELECTRIC CONDUCTIVITY OF U_3O_8 AS A FUNCTION OF OXYGEN PRESSURE BETWEEN 100 AND 700°C. Michel Murat and Charles Eyraud (Faculté des Sciences, Lyon). Bull. Soc. Chim. France, No. 11, 2589-90(1963). (In French)

The form of the variation of the electric conductivity of U_3O_8 in the presence of O_2 permits the characterization of this oxide as an n-type semiconductor (anionic vacancies). U_3O_8 fixes oxygen between 300 and 500°C, and the electric conductivity decreases with increasing oxygen pressure, in agreement with the reaction $\frac{1}{2} O_2 + 2 e^- \rightarrow 2 O^{2-}$. (tr-auth)

5263 KINETICS OF THE REACTION OF NIOBIUM PENTACHLORIDE WITH WATER VAPOR. T. R. Ingraham and B. J. P. Whalley (Dept. of Mines and Technical Surveys, Ottawa). Can. J. Chem. Eng., 41: 265-8(Dec. 1963).

When niobium pentachloride is exposed to moist air, hydrogen chloride is liberated and hydrated niobium pentoxide or niobic acid remains. It is believed that the rate of the reaction is controlled by the rate of diffusion of water across a layer of unidentified intermediate product of constant thickness (about 0.2 mm). The constant thickness of the layer is maintained by the spalling and cracking of the product after it exceeds a critical thickness. Since the reaction takes place at an interference between the niobium pentachloride and the layer of intermediate, it is necessary to normalize the results for the decrease in interfacial area as the reaction proceeds. When this is done, the rate of the reaction, expressed in terms of grams of niobium pentachloride reacting per square centimeter of interface per hour, is: Rate = $(7.7 \pm 0.4) \times 10^4 (p_i/p) \exp [(-8.1 \pm 0.6) \times 10^3]/RT$. (auth)

5264 PROMETHIUM. Thérèse Dupuis. Chim. Anal. (Paris), 45: 530-5(Oct. 1963). (In French)

After a brief review of the discovery and isolation of promethium, the chemical and physical properties of the element are summarized. The separation methods described are solvent extraction, precipitation, ion exchange, chromatography, and electrophoresis. (J.S.R.)

5265 NEW STUDIES ON THE M ABSORPTION SPECTRA OF TRANSURANIUM ELEMENTS (PLUTONIUM AND AMERICIUM). Yvette Cauchois, Christiane Bonnelle, and Louis de Bersuder. Compt. Rend., 257: 2980-3(Nov. 13, 1963). (In French)

The M absorption spectra of metallic Pu and Pu oxide are compared. The same technique is extended to Am and Am oxide. (tr-auth)

5266 COMPARISON OF THEORETICAL MAGNETIC SCREENING CONSTANTS AND DIAMAGNETIC SUSCEPTIBILITIES OF THE MOLECULES H_2, HD, AND D_2, INCLUDING THE EFFECT OF VIBRATION. Bernard Mangeot, Jean Guy, and Francoise Cabaret (Faculte de Pharmacie, Paris). Compt. Rend., 257: 3134-7(Nov. 18, 1963). (In French)

The magnetic screening constants ($\bar{\sigma}$) associated with the various nuclei present in a molecule are not in general determined theoretically except for the equilibrium case (in which the relative positions of the nuclei are assumed invariant). The average effect of molecular vibrations can be calculated only with difficulty, because knowledge of the potential curves relative to the normal vibrations is usually incomplete. The calculation ought, however, to be possible for the molecules H_2, HD, and D_2, using a Morse potential that agrees with the spectroscopic data. It is found by this calculation that $\bar{\sigma}(D_2) = \bar{\sigma}(HD) + 0.050 \times 10^{-6} = \bar{\sigma}(H_2) + 0.092 \times 10^{-6}$. It is easy to calculate under the same conditions the mean magnetic susceptibilities. The values obtained are: $\bar{\chi}(H_2) = -4.017 \times 10^{-6}$; $\bar{\chi}(HD) = -4.004 \times 10^{-6}$; and $\bar{\chi}(D_2) = -3.988 \times 10^{-6}$ (molar values, in cgs units). (tr-auth)

5267 ON THE PREPARATION OF SOLID SOLUTIONS OF THE OXIDES OF URANIUM AND THORIUM BY THE DECOMPOSITION OF THE MIXED OXALATE. André M. Badard and Jacques M. Pâris (Faculté des Sciences, Lyon). Compt. Rend., 257: 3421-3(Nov. 25, 1963). (In French)

The existence of a mixed oxalate of U(IV) and Th(IV), viz. $Th_xU_y(C_2O_4)_2 \cdot 6H_2O$ (with $x + y = 1$), is shown. The pyrolysis of this complex in a reducing atmosphere leads to a solid solution of the oxides of Th(IV) and U(IV), viz. $xThO_2 \cdot yUO_2$, above 700°C. (tr-auth)

5268 A STUDY OF THE $Th(NO_3)_4-HNO_3-H_2O-(C_4H_9O)_3$ EXTRACTION SYSTEM AT 25°C BY DETERMINING THE TIE LINES IN THE SYSTEM. A. V. Nikolaev, Yu. A. Afanas'ev, and A. I. Ryabinin (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 152: 1115-7(Oct. 11, 1963). (In Russian)

A series of experiments were carried out on the same initial solution at different phase ratios. The equilibrium concentrations of $Th(NO_3)_4$ and HNO_3, and the specific gravities of the aqueous and organic phases are tabulated, and the distribution coefficients for $Th(NO_3)_4$ and HNO_3 were calculated. The data are plotted on a triangular composition diagram, and the distribution coefficients of thorium are displayed on this plot as a function of the composition. Three sections can be distinguished on the composition plot: thorium is primarily extracted; the content of water and nitric acid remains relatively constant and the extraction is linear. $Th(NO_3)_4$ and HNO_3 is both extracted together. The extraction of thorium is being repressed by the presence of the nitric acid. HNO_3 is primarily extracted. The extraction of thorium is strongly repressed by the presence of nitric acid. (TTT)

5269 ION EXCHANGE AND ELECTROCHEMICAL PROPERTIES OF ZIRCONYL PHOSPHATES. B. P. Nikol'skii, E. A. Materova, and P. A. Skabichevskii (Leningrad State Univ.). Dokl. Akad. Nauk SSSR, 152: 1360-2(Oct. 21, 1963). (In Russian)

A zirconyl phosphate ion exchanger was obtained by precipitating zirconium oxychloride, chloride, or nitrate with phosphoric acid at room temperature, filtering off the precipitate, and drying at 120°C. The composition of the zirconyl phosphate precipitate was determined as K = moles of ZrO_2/ moles of P_2O_5, which varied from K = 1.07 to 2.98. The value of K increased on decreasing the acidity of the solution, and on increasing the ratio of ZrO_2/P_2O_5 in the initial solution. The exchange capacity of the zirconyl phosphate was determined by titrating with caustic. The exchange capacity depends on the pH of the contacting solution, and decreases with increasing value of K at any particular pH. The electrical conductivity decreases with increasing value of K. The double-charged Ca^{2+} ion is absorbed more strongly than the singly-charged Na^+ in acid or neutral solution. The following order is obtained if the ions are arranged with respect to decreasing affinity for zirconyl phosphate (K = 1): $Cu^{2+} > Zn^{2+} > Ba^{2+} > Ca^{2+} > Mg^{2+} > Na^+ > Li^{2+}$. Zirconyl phosphate ion exchangers with K > 1 can absorb anions from an acid solution. These inorganic ion exchangers are not subject to swelling, and are stable to radiation damage and high temperature. (TTT)

5270 PHASE RELATIONS IN THE SCANDIUM OXIDE–ALUMINUM OXIDE SYSTEM. N. A. Toropov and V. A. Vasil'eva (Inst. of Silicate Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 1379-82 (Oct. 21, 1963). (In Russian)

The phase diagram of the $Sc_2O_3-Al_2O_3$ system was determined by mixing Sc_2O_3 with Al_2O_3 in various proportions, annealing at a high temperature, and quenching from this temperature. Structural analysis, x-ray analysis, and infra-red spectroscopy were used to determine the phase changes. The existence of a binary compound $Sc_2O_3 \cdot Al_2O_3$ or $ScAlO_3$ was detected along with a region, where homogeneous crystals with a variable composition are formed. The invariant points of the system are: a eutectic of $Sc_2O_3 + Sc_2O_3$. Al_2O_3 + liquid at 1820°C, congruent melting

of Sc_2O_3 . Al_2O_3 + liquid at 1870°C, a solid phase invariant point of Sc_2O_3 + Sc_2O_3 . Al_2O_3 + S (homogeneous crystals having a variable composition) at 1730°C, a eutectic of Sc_2O_3 . Al_2O_3 + S + liquid at 1790°C, a reaction of Sc_2O_3 . Al_2O_3 + S + liquid at 1790°C, a peritectic point of S + α – Al_2O_3 + liquid at 1850°C. The scandium monoaluminate compound $ScAlO_3$ breaks down to Sc_2O_3 and crystals having a variable composition at a temperature below 1730°C. No solid solutions with Sc_2O_3 or with α–Al_2O_3 were found. (TTT)

5271 ZIRCONIUM AND HAFNIUM TRICHLORACETATES. I. A. Sheka, S. A. Kacherova, and L. A. Malinko (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 9, 1201-5(1963). (In Ukrainian)

Zirconium and hafnium trichloracetates were synthesized and the behavior of the compounds on heating and solution in mineral acids was studied. A study of the infrared absorption spectra of zirconium and hafnium trichloracetates, dioxides, and chloroxides led to the inference that there are $Zn(OH)_2^{2+}$ and $Hf(OH)_2^{2+}$ ions in the solid phase of the trichloracetates and chloroxides of zirconium and hafnium. (auth)

5272 HEXAFLUORIDES OF MOLYBDENUM, TUNGSTEN, AND URANIUM. II. REACTIONS WITH NITRYL FLUORIDE, NITROSYL FLUORIDE, AND NITROSYL CHLORIDE. J. R. Geichman, E. A. Smith, and P. R. Ogle (Goodyear Atomic Corp., Piketon, Ohio). Inorg. Chem., 2: 1012-15(1963). (GAT-T-1088/Rev.1)

Reactions of three metal hexafluorides with nitrosyl and nitryl fluorides resulted in solid compounds of the composition $NO_xF \cdot MF_6$ where x is 1 or 2 and M is W, Mo, or U. Infrared absorption data for these compounds indicate that the ionic form $NO_x^+MF_7^-$ and the molecular form $NO_xF \cdot MF_6$ contribute to the structure of the solid. Nitrosyl chloride does not act as do the nitrogen oxyfluorides with the hexafluorides but, like nitric oxide, it reduces molybdenum and uranium to complex nitrosyl fluorides of Mo(V) and U(V), with the formation of chlorine. Tungsten hexafluoride does not react with nitrosyl chloride. (auth)

5273 ACTIVATION ENERGY IN NIOBIUM DIFFUSION IN ITS OXIDES. P. V. Gel'd and V. D. Lyubimov (Ural Division of the Academy of Sciences, Sverdlovsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, 79-85(1963). (In Russian)

Self-diffusion of niobium cations in Nb_2O_5, NbO_2, and NbO at 900 to 1100°C was studied using radioactive tracers. It was shown that the activation energies of cation migration processes in Nb_2O_5 and NbO_2 are close to each other (E = 52 to 53 kcal) and almost twice that of NbO (E = 29.6 kcal). Small admixtures of TiO_2 and Na_2O do not influence the mobility of Nb^{5+} in Nb_2O_5. (R.V.J.)

5274 A NEUTRON DIFFRACTION STUDY OF α-LEAD AZIDE. G. L. Glen (Picatinny Arsenal, Dover, N. J.). J. Am. Chem. Soc., 85: 3892-4(Dec. 5, 1963).

A two-dimensional refinement of parameters of α-lead azide was made. A combination of Fourier difference synthesis and least-squares refinement was used. The y and z coordinates for each cycle were determined by averaging the values obtained from each type of analysis. Data are tabulated and the packing arrangement within the crystal is illustrated. (P.C.H.)

5275 MULTILAYER MEMBRANE ELECTRODES. IV. ACTIVITY OF MAGNESIUM AND STRONTIUM SALTS IN MIXED ELECTROLYTES. Harry P. Gregor, Alfred C. Glatz, and Harold Schonhorn (Polytechnic Inst. of Brooklyn, N. Y.). J. Am. Chem. Soc., 85: 3926-8(Dec. 20, 1963).

Magnesium stearate and strontium stearate multilayer membrane electrodes were prepared. Inserted in solution chains (at concentrations up to 3 to 4 molal) of the corresponding chloride salts between reversible electrodes, they gave potentials that agreed within experimental error with those calculated from thermodynamic data. Magnesium stearate multilayer electrodes were also employed to measure the activity coefficient of magnesium chloride in a mixed electrolytic solution with potassium chloride; good agreement with Harned's rule was observed at a total ionic strength of 1.0. Using appropriate electrodes, the activities of the chlorides of magnesium and strontium were measured in mixtures of these two salts, and again Harned's rule was observed, with the values of the two slopes being in agreement with derived thermodynamic relationships. (auth)

5276 ON THE HYDROGEN–DEUTERIUM EXCHANGE ACTIVITY OF SILICA GEL: ALUMINUM IMPURITY AND RADIATION EFFECT. Harold W. Kohn (Oak Ridge National Lab., Tenn.). J. Catalysis, 2: 208-10(June 1963).

The range of hydrogen–deuterium exchange on several silica gel samples was shown to increase with increasing alumina content. Chemisorption of hydrogen on gamma-irradiated gels and the increase of the exchange rate due to irradiation also increased with increasing alumina. Maximum obtainable exchange rates for silica samples which were extensively degassed are also reported. (auth)

5277 ELECTRONIC CALCULATION OF THE FORCE CONSTANTS AND OF THE INFRARED SPECTRUM OF THE MOLECULES H_2O AND D_2O. M. Allavena and S. Bratož (Centre de Mecanique Ondulatoire Appliquée, Paris). J. Chim. Phys., 60: 1199-1202(Oct. 1963). (In French)

The force constants of the molecule H_2O were calculated, beginning with the exact derivation of the molecular energy evaluated with the aid of an interaction wave function of monocentric configurations. The infrared spectra of H_2O and D_2O were deduced. Agreement with experiment is satisfactory. (tr-auth)

5278 ADSORPTION AND COADSORPTION STUDIES AT IONIZED SURFACE LAYERS BY MEANS OF α-DISINTEGRATION RECOILS. Menashe Avrahami and Naftali H. Steiger (Technion-Israel Inst. of Tech., Haifa). J. Colloid Sci., 18: 863-77(Dec. 1963).

Adsorption of ions at the surface of solutions of ionic surface-active substances can be studied directly using recoil atoms. Extremely small amounts of suitable radioactive ions, when added to such solutions, replace some of the normal counter-ions coadsorbed at the primary adsorbed organic ions. Recoiling atoms with energies from about 100 kev down to a few electron volts give ranges in water from about 1000 Å down to monomolecular layers. This makes them suitable for sensitive surface layer studies. The recoiling atoms ejected from the surface are collected and counted. Among α-disintegration recoils the system Bi^{212}/Tl^{208} proved to be suitable. Adsorption isotherms of Bi-ions as a function of the bulk concentration of the surface-active substance under varying conditions of ionic strength, pH, and Bi^{212} activity were measured. By comparing these isotherms with those obtained by measuring the surface tension of the solutions and calculating the surface excess, the adsorption of Bi^{3+} and Pb^{2+} relative to that of Na^+ and H_3O^+, and thus the extent of ion exchange in the adsorbed layer, was determined. As the method measures the adsorption of charged species, surface reactions

transforming primary adsorbed organic anions to a non-ionic state could be followed. (auth)

5279 THORIUM INTERACTION WITH THE SILANOL GROUP, WATER, AND NITRATE IN THE PORES OF SILICA GEL. Jimmy Stanton and Russell W. Maatman (Univ. of Mississippi, University). J. Colloid Sci., 18: 878-85(Dec. 1963). (TID-18079)

Solvation of Th^{4+} was observed by measuring the exclusion of $Th(ClO_4)_4$ from 50% of the pore volume of a high surface area silica gel under conditions of no cation exchange. Competition between Th^{4+} ions for water molecules increased as the concentration was increased from 0 to 0.4M. Enough water of hydration was removed from Th^{4+} hydrate by $HClO_4$ to increase the pore volume availability to 100% in 8M $HClO_4$. If HNO_3 replaced $HClO_4$ at 6 to 8M acid, the size of the thorium species increased markedly, presumably owing to $Th^{4+}-NO_3^-$ interaction. If, however, HNO_3 replaced $HClO_4$ at 1.5 to 2.7M acid, any $Th^{4+}-NO_3^-$ interaction merely replaced $Th^{4+}-H_2O$ interaction and a size change was not observed. The thermodynamic values for the exchange $Th^{4+} + 4\ SiOH \rightleftharpoons Th(OSi)_4 + 4\ H^+$ are: $\Delta F^0_{298} = 8.3$ kcal, $\Delta H^0 = 11.0$ kcal, and $\Delta S^0_{298} = 9.1$ eu. (auth)

5280 THE AQUEOUS SOLUTION BEHAVIOR OF LARGE UNIVALENT IONS. A NEW TYPE OF ION-PAIRING. R. M. Diamond (Univ. of California, Berkeley). J. Phys. Chem., 67: 2513-17(Dec. 1963). (UCRL-10909)

For large, unhydrated, univalent ions, a tightening of the surrounding water structure is a dominant feature of their aqueous solution behavior. As represented by their activity and osmotic coefficients, this corresponds to a rise in the coefficients above the Debye-Hückel limiting law, and the increase is larger, the larger the ion, but if both the cation and anion are such large hydrophobic ions, the hydrogen-bonded water structure forces them together to maximize the water-water interactions and to minimize the disturbance to itself. This water structure-enforced ion-pairing is very different from the more usual electrostatic, or Bjerrum, type of ion-pairing, occurring only in water, or other highly hydrogen-bonded solvents, and being greater, the larger the ions and the smaller their charges. Some chemical results of this type of ion-pairing are discussed. (auth)

5281 THE OXYGEN EXCHANGE REACTIONS OF NpO_2^{+2} AND NpO_2^+ WITH WATER. Sherman W. Rabideau (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 67: 2655-9(Dec. 1963). (LADC-5585)

Measurements of the rates of O^{18} exchange between labeled NpO_2^{+2} and H_2O were made with and without added oxidants. Nonlinear exchange plots obtained in the absence of oxidants were interpreted in terms of a catalysis by NpO_2^+. A value of 0.31 sec^{-1} was deduced from the exchange measurements for the specific rate constant for exchange between NpO_2^+ and H_2O in 1M $HClO_4$ at 23°C. In the presence of chlorine, linear exchange plots were found, but a catalysis was postulated in the experiments as well because of the variable half-times and the known relatively slow rate of reaction of NpO_2^+ with chlorine. Half-times for the $NpO_2^{+2}-H_2O$ oxygen exchange in the presence of permanganate and bromate ions were of the order of several hundred hours. From the data the specific rate constant for the $NpO_2^{+2}-H_2O$ exchange was found to be $\leq 6 \times 10^{-7}$ sec^{-1}. An acceleration of the rate of oxygen exchange between NpO_2^{+2} and H_2O was observed in the presence of ozone or cerium(IV) perchlorate. Exchange rates of the actinyl oxycations appear to be correlated with charge type and exchange similarities of isoelectronic members are not evident. (auth)

5282 THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS OF METALS IN THEIR MOLTEN HALIDES. VII. RARE EARTH METAL SYSTEMS. ELECTRON EXCHANGE BETWEEN ADJACENT OXIDATION STATES. A. S. Dworkin, H. R. Bronstein, and M. A. Bredig (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 2715-17(Dec. 1963).

The electrical conductivities of solutions of the series La, Pr, and Nd in their molten tribromides are similar to those of the corresponding chloride and iodide systems. The rapid increase in conductivity with metal concentration in the La solutions indicates the occurrence of considerable electronic conductance; in a solution of 10% La metal, as high as nine times the ionic conductance. The Nd solutions show little if any electronic conductance, while the Pr solutions are again intermediate. Solutions of Gd, Dy, Ho, and Er in their molten trichlorides behave irregularly both in regard to solubility and electrical conductance. A maximum in conductance near 50 mole % MX_2 dissolved in MX_3 was found in $NdBr_3-NdBr_2$ as it had been in NdI_3-NdI_2, and positive deviation from additivity was obtained in $DyCl_3-DyCl_2$, as in $NdCl_3-NdCl_2$. This maximum and positive deviation together with their absence in the systems $NdCl_3-SrCl_2$ and NdI_3-SrI_2 support an earlier explanation based on electron exchange between adjacent oxidation states ($Nd^{3+}-Nd^{2+}$, $Dy^{3+}-Dy^{2+}$). (auth)

5283 THERMOCHEMISTRY OF ANION MIXTURES IN SIMPLE FUSED SALT SYSTEMS. II. SOLUTIONS OF SOME SALTS OF MO_4^- AND MO_4^{-2} ANIONS IN THE CORRESPONDING ALKALI NITRATES. O. J. Kleppa and S. V. Meschel (Univ. of Chicago). J. Phys. Chem., 67: 2750-3 (Dec. 1963).

Calorimetric measurements were performed on the heats of solution and of dilution of potassium perchlorate in potassium nitrate, of sodium, potassium, rubidium, and cesium perrhenate in the corresponding nitrates, and of sodium sulfate, chromate, and molybdate in sodium nitrate. From the results were derived values of the interaction parameters for the liquid-liquid mixtures, and of the heats of fusion of the considered solutes at the temperatures of the measurements. New, approximate values of the heats of fusion (at the melting points) of the perrhenates and of potassium perchlorate are derived from the measurements. The new interaction parameters are discussed and compared with values previously obtained for the solutions of alkali bromides and chlorides in the nitrates. (auth)

5284 FREEZING POINT DEPRESSIONS IN SODIUM FLUORIDE. IV. EFFECTS OF TRIVALENT FLUORIDES. Stanley Cantor and Wilfred T. Ward (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 2766-9(Dec. 1963).

Freezing point depressions in NaF caused by the addition of up to 0.15 mole fraction of AlF_3, ScF_3, InF_3, YF_3, LaF_3, and eight rare earth trifluorides were measured as part of a program of investigating how thermodynamic behavior of fluoride melts is related to structural parameters of the components. The excess partial molal free energies of solution of NaF, $(\bar{F}-F^0)^E_{NaF}$, evaluated from the measurements, were all negative. For all the solutes except AlF_3 and InF_3, $(\bar{F}-F^0)^E_{NaF}$ was found to be inversely proportional to the interionic distance of the solute. The different solution behavior of AlF_3 and InF_3 was attributed to steric and polarization effects. The values of $(\bar{F}-F^0)^E_{NaF}$ with trivalent fluoride solutes were generally more negative than corresponding values with tetravalent solutes but less negative than the values with divalent solutes. (auth)

5285 THE ORIENTATION OF WATER MOLECULES IN THE FIELD OF AN ALKALI ION. Fred Vaslow (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 2773-6 (Dec. 1963).

Using the general series expansion for the potential due to an arbitrary charge distribution, and the quadrupole moment of a water molecule, it is shown that the minimum potential energy of small positive ions is not on the dipole axis of a water molecule but at a substantial angle to that axis. Making two different assumptions of the components of the quadrupole tensor of the water molecule, the electrostatic energies of the alkali ions in the field of a water molecule are calculated as a function of the angle of the ions with the dipole axis. It is found that over large regions of the hemisphere of a water molecule, away from the hydrogen atoms, the variation in energy of an ion is smaller than the energy of breaking a hydrogen bond. Since a hydrogen bond is also somewhat flexible in length and direction, it seems reasonable that for small ions hydration is not inconsistent with normal structural groupings that may exist in liquid water. A brief discussion is given of some possible consequences of these calculations to various hydration properties. (auth)

5286 THE CRYSTAL STRUCTURE OF STRONTIUM BROMIDE. Ronald L. Sass, Thomas Brackett, and Elizabeth Brackett (Rice Univ., Houston, Tex.). J. Phys. Chem., 67: 2862-3(Dec. 1963).

The crystal structure of $SrBr_2$ was investigated by the method of powder x-ray diffraction techniques. The resulting diffraction pattern was indexed on the basis of a tetragonal cell with a = 11.633 ± 0.009, c = 7.155 ± 0.008 Å. The observed systematic absences hkO; h + K = 1 (mod 2) are consistent with space group $D_{4h}^7 - P_n^{-4mm}$ or $C_{4h}^3 - P_n^{-4}$. Density measurements were consistent with 10 molecular units per cell. (P.C.H.)

5287 A DEUTERIUM ISOTOPE EFFECT ON CHEMICAL SHIFT. E. I. Snyder (Esso Research and Engineering Co., Linden, N. J.). J. Phys. Chem., 67: 2873-4(Dec. 1963).

The nuclear magnetic resonance spectrum of α deuteriostyrene, $C_6H_5CD=CH_2$ was observed. The observations confirmed that proton resonance frequency is dependent upon the particular hydrogen isotope present in some part of the molecule. (P.C.H.)

5288 VAPORIZATION OF URANIUM MONOPHOSPHIDE. K. A. Gingerich (Pennsylvania State Univ., University Park), P. K. Lee, and J. Efimenko. Nature, 200: 774-6(Nov. 23, 1963).

The thermodynamics of vaporization of uranium monophosphide, UP, at 1750 to 2250°K are reported. During vaporization the major primary ion species observed and measured were U^+, P^+, P_2^+, and UO^+. No uranium dioxide was detected in the residue and the UO ion intensity decreased in relation to the U^+ ion intensity as the vaporization progressed. The derived values for partial molal heats of vaporization in kilocalories per mole, at 2000°K are: $\Delta H(U) = 131.69 \pm 2.25$; $\Delta H(P) = 119.94 \pm 2.63$; and $\Delta H(P_2) = 105.46 \pm 1.66$. From these values a heat of vaporization, ΔH vap, in kilocalories per mole of UP was obtained as 184.42 ± 3.08 for the reaction $UP_{(s)} = U_{(g)} + (1/x)P_{x(g)}$ where x = 2 and 251.63 ± 4.88 when x = 1. The results implied that above 2600°K the vaporization of UP becomes incongruent. (P.C.H.)

5289 EVIDENCE FOR HINDERED ROTATION OF THE BeF_4 IONS IN FERROELECTRIC $(GLYCINE)_3BeF_4$. R. Blinc and I. Zupančič (Nuclear Inst., "J. Stefan," Ljubljana, Yugoslavia). Phys. Chem. Solids, 24: 1379-80 (Nov. 1963).

The results of a F^{19} magnetic resonance absorption study in $(glycine)_3BeF_4$ (TGBe), bearing direct evidence for hindered rotation and "freezing in" of the BeF_4 ions in the ferroelectric phase, are reported. Measurements were made of the F^{19} magnetic resonance spectra from −175 to 100°C both on a single crystal and on a powdered sample of TGBe. The angular dependence of the single crystal spectra showed marked anisotropy. On cooling below the Curie temperature (Tc), only a very small change in line width and second moment at certain orientations could be detected in the single crystal spectra. No significant change was found in the powder spectra. Some 50°C below Tc, however, a well-defined line width transition, centered at 0°C, set in. The second moment of the powder spectra increased from 5 at 23°C to about 12.5 G^2 at −50°C. At still lower temperature, below −130°C, a second line width transition occurred. Data indicated that the characteristic frequency of molecular motion may well lie in the 10^7 cps region at Tc. (M.C.G.)

5290 OPTICAL AND ELECTRICAL PROPERTIES OF LaB_6. E. Kauer (Philips Zentrallaboratorium GmbH, Aachen). Phys. Letters, 7: 171-3(Nov. 15, 1963).

The electric conductivity and its temperature dependence, electron concentration and mobility, and the spectral reflectance of LaB_6 were determined. (C.E.S.)

5291 ON THERMAL DIFFUSION COLUMN SHAPE FACTORS INCLUDING THE TEMPERATURE DEPENDENCE OF THE THERMAL DIFFUSION FACTOR. G. Reinhold (Deutchen Akademie der Wissenschaften, Berlin). Phys. Letters, 7: 189-90(Nov. 15, 1963).

The temperature dependence of the thermal diffusion factor is used to calculate the thermal diffusion column shape factors of Ne and Ar. The numerical calculation is carried through for the special values of the inverse power potential index n = 1, ¾, and ½. (C.E.S.)

5292 HIGH ENERGY MODES IN THE FREQUENCY DISTRIBUTION OF GRAPHITE. P. A. Egelstaff and D. H. C. Harris (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 7: 220(Nov. 15, 1963).

The energy distribution of cold neutrons scattered from graphite at 950°C was measured. The data show the existence of three peaks in the frequency distribution at energies of 0.08, 0.12, and 0.18 ev and a Debye cut-off at ~0.22 ev. (C.E.S.)

5293 NUCLEAR MAGNETIC RELAXATION IN NaCl AT HIGH TEMPERATURES. Maurice Eisenstadt (Columbia Univ., New York). Phys. Rev., 133: A191-7(Jan. 6, 1964).

Measurements of T_1 and T_2, the spin-lattice and spin-spin relaxation times, are reported for Na^{23} and Cl^{35} nuclei in NaCl from room temperature to the melting point. For single-crystal samples below 700°K, T_1 is due to quadrupolar interactions of the nuclei with lattice vibrations and diffusing vacancies, and T_2 arises from the dipolar interaction between nuclei. A jump frequency for positive ion vacancy motion of 4×10^7 sec^{-1} at 510°K is obtained, in good agreement with conductivity measurements. At higher temperatures a number of anomalous features appear and possible explanations are discussed. (auth)

5294 DECOMPOSITION OF CESIUM DIIODO ASTATATE (I), ($CsAtI_2$). G. A. Brinkman, J. Th. Veenboer, and A. H. W. Aten, Jr. Radiochim. Acta, 2: 48(Oct. 1963).

$CsAtI_2$ in CsI_3 was prepared. On heating this material it

was observed that essentially all of the astatine was present in the gaseous iodine fraction. In 5 experiments the fraction of the total astatine recovered in the I_2 (as AtI) vapor amounted to 95, 97, 86, 97, and 110%. (M.C.G.)

5295 CHEMICAL COMPOUNDS OF THE NOBLE GASES. Cedric L. Chernick (Argonne National Lab., Ill.). Record Chem. Progr. (Kresge-Hooker Sci. Lab.), 24: 139-55(Sept. 1963).

A historical review is presented of the prediction and discovery of compounds of Kr, Xe, and Rn. The many attempts to prepare the compounds are described. The properties and structure of Xe compounds are discussed in detail. A bibliography of 123 references is included. (D.L.C.)

5296 SPECIFIC HEAT OF EuS. V. L. Moruzzi and D. T. Teaney (International Business Machines Corp., Yorktown Heights, N. Y.). Solid State Commun., 1: 127-31 (Nov. 1963).

Specific heat measurements of EuS between 10 and 35°K show a sharp peak at 16.2°K. The measurements are analyzed using the constant coupling approximation, and it is shown that the dominant exchange interaction is between nearest neighbor Eu^{++} ions. (auth)

5297 CHEMICAL REACTIONS IN THE PLASMA JET. H. M. Hulburt (Northwestern Univ., Evanston, Ill.) and M. P. Freeman. Trans. N. Y. Acad. Sci., 25: 770-86(May 1963).

Chemistry at extremely high temperatures, especially of ionized gases, or plasma, is discussed. As an example, the properties of nitrogen at atmospheric pressure at temperatures from about 3000° to 25000°K are described. Methods for generating a plasma at 15000°K at atmospheric pressure are outlined and illustrated by use of an open electric arc for which the temperature ordinarily varies from 6000 to 8000°K. The production and characteristics of the plasma jet are explained, with reference to a small commercial plasma jet of 40-kw capacity. Applications of the plasma jet principle, particularly for the production of acetylene, are discussed. In a survey of possible plasma jet applications where the price of heat is that of electricity, molecules with atoms of high atomic weight will be most promising. The use of extremely fast cooling rates in a plasma to make very finely divided nickel powder by the thermal decomposition of nickel carbonyl are described. The so-called intermediate section plasma jet reactor is described and discussed in detail. Preliminary results of experiments in a nitrogen plasma that take advantage of the rapid temperature drop experienced by the effluent plasma to freeze and determine the equilibrium population of atomic species are reported. When methane is fed to the nitrogen jet, it is rapidly converted to C_2 and precursors at the high temperatures involved. When these collide with nitrogen atoms or ions, CN radicals should form, which in the cooler portions of the jet combine with hydrogen to form HCN. (BBB)

5298 SPECTROPHOTOMETRIC STUDIES ON THE ACETATE COMPLEXES OF QUADRIVALENT PLUTONIUM IN AQUEOUS SOLUTION. E. Nebel and K. Schwabe (Inst. for Nuclear Physics, Rossendorf, Ger.). Z. Physik. Chem. (Leipzig), 224: 29-50(1963).

The formation of quadrivalent plutonium complexes was studied in aqueous sodium acetate solutions in relation to pH. The values of the stability constants were determined. The composition and formation characteristics of various complexes were also determined. (TCO)

5299 HIGH-TEMPERATURE EQUILIBRIUM OF THE REACTION HfN + C ⇌ HfC + $\frac{1}{2}N_2$. K. I. Portnoi and Yu. V. Levinskii. Zh. Fiz. Khim., 37: 2467-73(Nov. 1963). (In Russian)

The equilibrium of the reaction HfN + C ⇌ HfC + $\frac{1}{2}N_2$ was investigated by chemical and x-ray methods. The limiting stage of the equilibration process was found to be diffusion in the solid phase. The temperature dependence of the equilibrium constant reaction in the temperature range 1700 to 2300°C is shown to obey the equation $\lg K_p = -3380/T + 2.00$. The equilibrium constant calculated from thermodynamic data is in satisfactory agreement with the experimental values. (auth)

5300 COMPLEXING OF URANIUM(IV) WITH ETHYLENEDIAMINETETRAACETIC ACID. N. P. Ermolaev and N. N. Krot. Zh. Neorgan. Khim., 8: 2447-61(Nov. 1963). (In Russian)

Spectrophotometric and potentiometric analyses of U(IV) behavior in weakly acidic, neutral, and alkali solutions with ethylenediaminetetraacetic acid (EDTA) showed that with the increase of pH the complex ($UY:2H_2O$) undergoes a gradual hydrolysis resulting in $[UYOH \cdot H_2O]^-$, $UY(OH)_2^{2-}$, and $UY(OH)_3^{3+}$ ions. Formation and dimerization constants of hydrocomplexes $[UYOH \cdot H_2O]^-$ and $UY(OH)_2^{2-}$ were determined. Reactions of U(IV) with saturated EDTA resulted in formation of $(H_2U_2Y_2)^{2-}$ with pH 2 to 3; with an increased pH the H^+ ions break away changing the complex into $[U_2Y_3]^{4-}$. A gradual hydrolysis in weakly alkaline solutions forms $(UOH)_2Y_3^{6-}$ ions. Equilibrium constants were determined for ions $[H_2U_2Y_3]^{2-}$, $[HU_2Y_3]^{3-}$, $[U_2Y_3]^4$, and $(UOH)_2Y_3^{6-}$. Reactions of EDTA with saturated U(IV) formed complexes with the metal-addend ratio 2:1. The following solid complexes were prepared by U(IV) reaction with EDTA: $K_2H_2U_2Y_3 \cdot nH_2O$, $(NH_4)_2H_2U_2Y_3 \cdot nH_2O$, $Ba_2U_2Y_3 \cdot 18H_2O$, $Sr_2U_2Y_3 \cdot 18H_2O$, $Ca_2U_2Y_3 \cdot 12H_2O$, and $U_2Y(OH)_4 \cdot nH_2O$. (R.V.J.)

5301 COMPLEX FORMATE THORIUM COMPOUNDS. V. A. Golovnya and O. M. Ivanova (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2462-9(Nov. 1963). (In Russian)

Studies were made of physical and chemical properties of complex thorium formate compounds and new thorium complexes of $Cs[Th(HCO_2)_5]$, $Cs_2[Th(HCO_2)_6]$, $Cs_3[Th(HCO_2)_7]$, and $Cs_4[Th(HCO_2)_8]$ were prepared. A gradual saturation of thorium formate compounds resulted in separate transitional series. The stability of thorium hydrate formate solutions increased in transition from lower genetic formate series to the higher ones. (R.V.J.)

5302 ON THE STRUCTURE OF Th AND La COMPLEXES WITH ARSENAZO(III). S. B. Savvin and M. P. Volynets (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2470-8(Nov. 1963). (In Russian)

The mechanism of arsenazo III reaction and complexing with La and Th was analyzed and it was shown that two symmetric functionally-analytical groups of arsenazo III molecules participate in the two weakly reacting conjugated systems. Reactivity of only one of the group produces two absorption bands. The compositions of two- and three-charged cation complexes correspond to MeR. Reactions with La emitted two protons. Two compositions were observed in four-charged elements (MeR) and (MeR_2). In the first case reactions with Th emitted 3 protons; in the second 4 protons. (R.V.J.)

5303 SPECTROPHOTOMETRY OF CERIUM(IV) SULFATE COMPLEXES. L. T. Bugaenko and Kuang-lin

Huang. Zh. Neorgan. Khim., 8: 2479-82(Nov. 1963). (In Russian)

Absorption spectra for Ce(IV) sulfates with 0.1 to 17.6 mole H_2SO_4 were studied at λ = 250 to 500 mμ. Equilibrium constants and molar quenching coefficients were determined for each complex at λ = 305 and 320 mμ. (R.V.J.)

5304 REACTIONS OF ZIRCONIUM OXYCHLORIDE WITH AMMONIUM CARBONATE. T. F. Limar and K. P. Shatskaya (All-Union Research Inst. of Chemical Reagents and Pure Chemical Substances, USSR). Zh. Neorgan. Khim., 8: 2483-9(Nov. 1963). (In Russian)

Measurements of electric conductivity, solubility, pH, and precipitation of $ZrOCl_2-(NH_4)_2CO_3-H_2O$ system indicated that reactions of zirconium hydrochlorides with ammonium carbonate results in two compounds with Zr^{4+}: CO^{2-} ratio 1:1 and 1:2 (the first product appears in a powder form; the other as a soluble compound). (R.V.J.)

5305 SPECTROPHOTOMETRY OF RARE EARTH COMPLEXING WITH DIETHYLENETRIAMINEPENTA-ACETIC ACID. Yu. P. Galaktionov and K. V. Astakhov (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 8: 2493-7(Nov. 1963). (In Russian)

Complex formation of Nd^{3+} with diethylenetriaminepenta-acetic acid (DTPA) in solutions was investigated by spectrophotometric method. It was found that Nd^{3+} with DTPA formed two complexes: NdX^2 (with pH 2.5) and Nd_2X^+ (with pH > 6). Instability and acidolysis constants were determined and the results compared with published data. (R.V.J.)

5306 SPECTROPHOTOMETRY OF NEODYMIUM(III) COMPLEXES WITH HEXAMETHYLENEDIAMINETETRA-ACETIC ACID–ACETIC ACID–WATER. Yu. P. Galaktinov and K. V. Astakhov (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 8: 2498-2506(Nov. 1963). (In Russian)

Spectrophotometric studies of complex formation of Nd^{3+} and hexamethylenediaminetetraacetic acid systems $Nd(ClO_4)_3-HAc$; $Nd(ClO_4)_3-H_4Z$, $Nd(ClO_4)_3-H_4Z-HAc$ revealed the following complexes: $MeAc^{2+}$, $MeAc_2^+$, and $MeAc_3$ for the first system, MeH_2Z^+, MeH_2Z, and $MeH_2Z_2^{3-}$ for the second, and MeHZAc, $MeH_2Z_2Ac^{4-}$ for the third. Acidolysis constants and gradual dissociation constants were calculated for all developed conplexes. (R.V.J.)

5307 SAMARIUM AND EUROPIUM ORTHONIOBATES. E. I. Krylov and V. N. Sanatina (Ural Polytechnic Inst., USSR). Zh. Neorgan. Khim., 8: 2507-9(Nov. 1963). (In Russian)

Studies were made of $EuNbO_4$ synthesis and stability and magnetic properties of $SmNbO_4$ and $EuNbO_4$. It was found that the salts are thermally stable to 1250°. Thermal stability of rare earth orthoniobates was compared with alkali metal metaniobates. Magnetic susceptibility of $SmNbO_4$ and $EuNbO_4$ was measured at 78, 194, and 290°K and it was shown that $\chi(1^-/m)$ of T is not linear. (R.V.J.)

5308 ROENTGENOGRAPHIC STUDIES OF NIOBIUM AND TANTALUM PENTABROMIDES. S. S. Berdonosov, A. V. Lapitskii, D. G. Berdonosova, and L. G. Vlasov (Moscow State Univ.). Zh. Neorgan. Khim., 8: 2510-12 (Nov. 1963). (In Russian)

Axial parameters for elementary cells of $NbBr_5$ (a = 6.127 Å, b = 12.98 Å, and c = 18.55 Å) and TaBr (a = 6.155 Å, b = 13.29 Å, and c = 18.66 Å) were verified and their orthorhombic structure confirmed. Specific weights calculated under the assumption that z = 8 were for $NbBr_5$ $d_{x\text{-ray}}$ = 4.434 g/cm^3 and $TaBr_5$ $d_{x\text{-ray}}$ = 5.050 g/cm^3. The results are in good agreement with pycnometric specific weight (for $NbBr_5$ d_4^{25} = 4.360 ± 0.005 g/cm^3 and for $TaBr_5$ d_4^{25} = 4.986 ± 0.003 g/cm^3). (R.V.J.)

5309 PRASEODYMIUM CHROMATES IN Pr, $K||CrO_4$, NO_3-H_2O. F. M. Peril'man and E. I. Fedoseeva (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2603-7(Nov. 1963). (In Russian)

Quadrupole systems of Pr^{3+}, $K^+||NO_3^-$, $CrO_4^{2-} + H_2O$ were studied by the solubility method at the praseodymium chromate and binary chromate crystallization range. It was found that the systems form two binary salts $Pr_2(CrO_4)_3 \cdot K_2CrO_4 \cdot nH_2O$ and $Pr_2(CrO_4)_3 \cdot 3.5\,K_2CrO_4 \cdot nH_2O$. A normal praseodymium chromate $Pr_2(CrO_4)_3 \cdot 8H_2O$ was formed in systems saturated with praseodymium. (R.V.J.)

5310 MULTIATOMIC GRAPHITE MOLECULES. M. S. Chupakhin, G. G. Glavin, and L. T. Duev. Zh. Tekhn. Fiz., 33: 1281-4(Oct. 1963). (In Russian)

Multi-atomic carbon molecules were recorded to (m/c) = 240(C_{20}), and their concentrations were determined in spectrally pure graphite by mass spectroscopy. It is shown that variations from 40 v and above do not influence the yield of multi-atomic carbon in annealed and non-annealed graphite specimens. The mechanism of multi-atomic carbon formation in spark sources is discussed. (R.V.J.)

5311 NOBLE-GAS COMPOUNDS. Herbert H. Hyman, ed. Chicago, University of Chicago Press, 1963. 414p.

Fifty-eight articles are included: separate abstracts were prepared for 39. Seventeen articles were previously abstracted in NSA. One article on a new epoch in chemistry was not abstracted. (P.C.H.)

For abstracts of individual papers see: 4993, 5312, 5313, 5314, 5315, 5316, 5317, 5318, 5319, 5320, 5321, 5322, 5323, 5324, 5325, 5326, 5327, 5328, 5329, 5330, 5331, 5332, 5333, 5334, 5335, 5336, 5337, 5338, 5339, 5340, 5341, 5342, 5343, 5344, 5345, 5346, 5347, 5348, and 5349.

5312 HISTORICAL REMARKS ON THE DISCOVERY OF ARGON, THE FIRST NOBLE GAS. Erwin N. Hiebert (Univ. of Wisconsin, Madison). p.3-20 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A review on the discovery of argon is presented. (P.C.H.)

5313 THE XENON–PLATINUM HEXAFLUORIDE REACTION AND RELATED REACTIONS. Neil Bartlett and N. K. Jha (Univ. of British Columbia, Vancouver). p.23-30 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Xenon and platinum hexafluoride interact at room temperature to form a red solid of composition $Xe(PtF_6)_x$ where x lies between 1 and 2. That the platinum is present in the +5 oxidation state, no matter what the composition of the adduct, is indicated by the preparation of alkali metal hexafluoroplatinates(V) from material of composition $XePtF_6$ and $Xe(PtF_6)_2$. Material containing more than one mole of platinum hexafluoride per gram atom of xenon combines with more xenon at 130° to approach the composition $XePtF_6$. Xenon tetrafluoride is liberated in the pyrolysis of platinum hexafluoride–rich adduct, $Xe(PtF_6)_{1.8}$. The residual, brick-red, diamagnetic, xenon-containing platinum compound has a composition close to $XePt_2F_{10}$. Rhodium hexafluoride forms a deep-red adduct with xenon, the composition of which is close to $XeRhF_6$. Krypton does not react with either platinum hexafluoride or with rhodium hexafluoride at temperatures below 50°. (auth)

5314 REMARKS RELATIVE TO THE FIRST XENON TETRAFLUORIDE PREPARATION. H. H. Claassen,

John G. Malm, and H. Selig (Argonne National Lab., Ill.). p.31-2 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The reaction between xenon and fluorine was done quantitatively, using a thin-walled nickel can that could be weighed. From weights combined, the formula XeF_4 was arrived at, and evidence for the existence of a lower fluoride was also obtained. Visual evidence was obtained by subliming some of the material into glass. The formula was verified by chemical analysis. (P.C.H.)

5315 THE USE OF INFRARED SPECTROSCOPY IN THE PREPARATION AND STUDY OF XENON COMPOUNDS. D. F. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.). p.39-46 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963. (TID-18675)

A circulating loop containing an infrared cell located in a spectrophotometer beam was designed for studying the corrosive fluorine-containing gases and their volatile reaction products. The loop was used to study $Xe-F_2$ and XeF_2-F_2 reactions and to prepare small quantities of fairly pure XeF_2. It was also used to test the purity and to improve the purity of XeF_2, XeF_4, and XeF_6 preparations. Small quantities of $XeOF_4$ were prepared by the hydrolysis of XeF_6, and the vapor pressure as a function of temperature was determined for $XeOF_4$ and the xenon fluorides. A schematic diagram of the loop is presented. (P.C.H.)

5316 MASS-SPECTROMETRIC STUDIES OF NOBLE-GAS COMPOUNDS. Martin H. Studier and Eric N. Sloth (Argonne National Lab., Ill.). p.47-9 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Mass spectrometric studies were made on Xe, XeF_4, XeF_2, and XeF_6. The formula of the oxyfluoride $XeOF_4$ was deduced from its mass and the complexity of the fragmentation pattern caused by loss of either oxygen or fluorine atoms. No spectrum attributable to XeF_3 was observed, although copious evolution of Xe and O suggested the presence of an oxide. (P.C.H.)

5317 THE XENON–FLUORINE SYSTEM. Bernard Weinstock, E. Eugene Weaver, and Charles P. Knop (Ford Motor Co., Dearborn, Mich.). p.50-60 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

In a method of preparation for XeF_6, Xe and F were reacted at a high temperature and the products formed were rapidly cooled to a lower temperature. In the initial preparations the ratio of fluorine to Xe was varied from 6 to 40 and their combined starting pressure was 1000 psi. Reaction temperatures in the range 350–450°C were provided by an electrically heated nickel-gauze filament and the reactor wall kept either at −115 or at 80°C to provide the quenching. XeF_6 was produced in all of the experiments as well as XeF_2, XeF_4, and another xenon fluoride that was not immediately characterized. The presence of the compounds was qualitatively monitored by infrared spectroscopy. XeF_6 was identified with a strong absorption at 610 cm^{-1}, XeF_2 with bands at 551 cm^{-1} and 567 cm^{-1}, and XeF_4 with bands at 582 and 592 cm^{-1}. The spectrum of the unidentified compound showed a broad absorption system with a characteristic maximum at 520 cm^{-1}. Evidence strongly suggests that the compound at 520 cm^{-1} is XeF_5. However, it is pointed out that while the evidence is strongly suggestive of this formula, it is still incomplete. (P.C.H.)

5318 ON THE SYNTHESIS OF HIGHER XENON FLUORIDES. J. Slivnik, B. Volavšek, J. Marsel, V. Vrščaj, A. Šmalc, B. Frlec, and A. Zemljič (Nuclear Inst. "Jozef Stefan," Ljubljana, Yugoslavia). p.64-7 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A method and conditions for the preparation of higher fluorides, XeF_6 and XeF_8, are reported. (P.C.H.)

5319 FLUORINE EXCHANGE BETWEEN XENON HEXAFLUORIDE AND GASEOUS FLUORINE. Irving Sheft and H. H. Hyman (Argonne National Lab., Ill.). p.68-70 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The rate of exchange of fluorine between XeF_6 and gaseous fluorine was found to be a linear function of fluorine concentration and to extrapolate back through zero. In a single exchange between 0.014 moles/liter XeF_6 and 1.10 moles/liter F_2 at 100 C, a rate of exchange of 0.078×10^{-3} mole $liter^{-1}$ min^{-1} was obtained. An activation energy of 20 kcal/mole is calculated from the results. Although the results of the XeF_6-F_2 exchange experiments do not completely rule out an association complex with fluorine atoms, the data are best explained by an exchange mechanism involving a complex with fluorine molecules. (P.C.H.)

5320 SOME PROPERTIES OF THE XENON FLUORIDES. A. J. Edwards, J. H. Holloway, and R. D. Peacock (Univ. of Birmingham, Eng.). p.71-2 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Chemical properties of XeF_4 are reported and discussed. The properties, which are incomplete, show that the XeF_4 is a poorer Lewis acid than iodine pentafluoride and that it is a Lewis base only under special conditions. A lack of reactivity of XeF_4 towards BF_3 suggests that π-bonding plays an important part in complex formation. (P.C.H.)

5321 PREPARATION OF RARE-GAS FLUORIDES AND OXYFLUORIDES BY THE ELECTRIC-DISCHARGE METHOD AND THEIR PROPERTIES. A. G. Streng, A. D. Kirshenbaum, L. V. Streng, and A. V. Grosse (Temple Univ., Philadelphia). p.73-80 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A number of noble-gas compounds were prepared with the aid of an electric discharge: with xenon and fluorine alone, XeF_4 and XeF_6; with krypton and fluorine, KrF_4; with xenon and oxygen difluoride, $XeOF_2$. A product containing one or more compounds having the approximate formula $XeOF_3$ was prepared by heating Xe and OF_2. (auth)

5322 PHOTOCHEMISTRY OF THE FORMATION OF XENON DIFLUORIDE. James L. Weeks and Max S. Matheson (Argonne National Lab., Ill.). p.89-97 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Xenon and fluorine combine photochemically when irradiated with near ultraviolet light in the fluorine absorption band. If the product is continuously trapped out, essentially pure XeF_2 is produced. Fluorine and XeF_2 will further react photochemically to produce XeF_4. Quantum yields for XeF_2 formation are of the order of 0.3 to 0.7, being somewhat lower at higher pressures, especially at higher pressures of fluorine. The mechanism of formation very probably involves fluorine atoms. A transient intermediate, perhaps XeF, was detected in flash photolysis experiments. Attempts at the photochemical preparation of other rare-gas compounds have not yet been successful. (auth)

5323 ON THE FLUORINATION OF XENON: XENON DIFLUORIDE. Rudolf Hoppe, Harald Mattauch, Karl-Matin Roedder, and Wolfgang Daehne (Universität, Münster, Ger.). p.98-100 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A method is described for the preparation of XeF_2 by electric discharge using an induction coil. Pure XeF_2 was obtained. (P.C.H.)

5324 PREPARATION OF INERT-GAS COMPOUNDS BY MATRIX ISOLATION: KRYPTON DIFLUORIDE. J. J. Turner and G. C. Pimentel (Univ. of California, Berkeley). p.101-5 of "Noble-Gas Compounds." Chicago, University of Chicago Press, 1963.

A method for the preparation of KrF_2 by matrix isolation is described. The force constants of KrF_2 were found to be close to those of XeF_2. It was concluded that the matrix-isolation technique is a useful preparative method for inert-gas compounds, and it may have unique value for those that are least stable. (P.C.H.)

5325 XENON OXYTETRAFLUORIDE. Cedric L. Chernick, H. H. Claassen, John G. Malm, and P. L. Plurien (Argonne National Lab., Ill.). p.106-8 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Xenon oxytetrafluoride, $XeOF_4$, was prepared by the reaction of xenon hexafluoride with water or silica. The compound is a colorless liquid with a melting point of −28°C and a vapor pressure of 8 mm at 0°. (auth)

5326 POTENTIAL APPLICATIONS OF THE NOBLE-GAS COMPOUNDS. J. H. Pomeroy (U. S. Atomic Energy Commission, Washington, D. C.). p.123-5 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Speculation on the applications of the noble gas compounds is presented. (P.C.H.)

5327 SAFETY PRECAUTIONS IN HANDLING NOBLE-GAS COMPOUNDS. R. B. Smith (U. S. Atomic Energy Commission, Washington, D. C.). p.126-9 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A set of interim safeguards are suggested for handling XeO_3 and xenon fluorides and oxyfluorides. Also, until such time as adequate hazard knowledge and experience are developed locally to warrant lesser precautions, the safeguards are suggested for all other noble gas compounds. (P.C.H.)

5328 THE HEAT CAPACITY AND RELATED THERMODYNAMIC FUNCTIONS OF XENON TETRAFLUORIDE. W. V. Johnston, D. Pilipovich, and D. E. Sheehan (North American Aviation Science Center, Canoga Park, Calif.). p.139-43 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Measurements of the heat capacity and specific heat of XeF_4 at 20°K to room temperature are reported. The entropy of XeF_4 from 0 to 298.16°K was determined from the heat capacities. The entropy of formation and free energy of formation of XeF_4 at 25°C were found to be −102.5 cal $mole^{-1}$ deg^{-1} and −29.4 kcal $mole^{-1}$, respectively. (P.C.H.)

5329 AQUEOUS SOLUTION CHEMISTRY OF XENON. AN INTRODUCTION. Martin Kilpatrick (Argonne National Lab., Ill.). p.155-7 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The hydrolysis of xenon fluorides is discussed. Hydrolysis experiments showed that in addition to the oxidation of water to oxygen there is a disproportionation of the xenon compound to higher and lower valence states for the tetra- and hexafluorides. (P.C.H.)

5330 THE REACTION OF XENON TETRAFLUORIDE WITH AQUEOUS SOLUTION: CHEMISTRY OF XENON TRIOXIDE. Stanley M. Williamson and Charles W. Koch (Univ. of California, Berkeley). p.158-66 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The hydrolysis of XeF_4 in aqueous solutions was studied. In addition to the direct oxidation of water by XeF_4 to give oxygen, xenon, and hydrofluoric acid, the reaction also gave a very soluble xenon (VI) species. The decomposition, chemical properties, and reactions of XeO_3 are discussed. (P.C.H.)

5331 THE REACTION OF AQUEOUS XENON TRIOXIDE WITH BROMIDE AND IODIDE ANION: A KINETIC STUDY. Charles W. Koch and Stanley M. Williamson (Univ. of California, Berkeley). p.181-4 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The oxidation of bromide to bromine by XeO_3(aq) was found to be acid dependent and the rate in the pH range of 1 to 0 was readily measurable. Iodide was oxidized to iodine extremely rapidly at pH values <6, but in the region 6 to 7, rate measurements were made. Rates at 0.2, 24.8, and 39.9°C were observed to measure the energy of activation for the two reactions. The appearance of Br_3^- and I_3^- as a function of time was observed colorimetrically on a spectrophotometer at 2650 and 2870 A, respectively. Consideration of the stoichiometric equation $XeO_3(aq) + 6H^+ + 9X^- \rightarrow Xe + 3H_2O + 3X_3^-$ directly gave the changes in concentrations of all species. (P.C.H.)

5332 CRYSTALLOGRAPHIC STUDIES OF XENON DIFLUORIDE, XENON TETRAFLUORIDE, AND SOME SODIUM XENATE HYDRATES. S. Siegel and E. Gebert (Argonne National Lab., Ill.). p.193-4 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

XeF_2 is tetragonal with a = 4.315 ± 0.003 and c = 6.900 ± 0.004 Å. The space group is I4/mmm with Xe atoms in 0,0,0; ½,½,½, and F atoms in 00z, 00$\bar{z}$ + b.c. The two molecules in the cell lead to a density of 4.32 g/cc. A value z = 0.306 ± 0.02 determined by x rays leads to linear F-Xe-F molecules with Xe-F = 2.14 ± 0.14 Å. XeF_4 crystals are monoclinic with a = 5.03, b = 5.92, and c = 5.79 Å, and β = 99°27'. The space group is $P2_1/n$ with Xe atoms in 0,0,0; ½,½,½, and F atoms in general positions. The computed density based on the two molecules in the cell, is 4.04 g/cc. A planar character for the molecule is indicated by the symmetry. The hydrolysis product, $Na_4XeO_6 \cdot 5H_2O$, (now established as $Na_4XeO_6 \cdot 8H_2O$) was found to be orthorhombic with a = 10.36, b = 10.45, and c = 11.87 Å. A product of composition, $Na_4XeO_6 \cdot 2H_2O$, is also orthorhombic with a = 6.25, b = 5.77, and c = 10.28 Å. (P.C.H.)

5333 THE CRYSTAL AND MOLECULAR STRUCTURE OF XENON TETRAFLUORIDE BY NEUTRON DIFFRACTION. John H. Burns, Paul A. Agron, and Henri A. Levy (Oak Ridge National Lab., Tenn.). p.211-20 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The crystal structure, molecular geometry, and thermal motion of xenon tetrafluoride were determined by three-dimensional neutron-diffraction analysis. The symmetry of the XeF_4 molecule was found to be D_{4h} to high precision. The average Xe-F bond length, corrected for thermal motion, is 1.95 (σ = 0.01)A, and the F(1)-Xe-F(2) angle is 90.0 (σ = 0.1)°. Thermal motion in the crystal is described as a translation of the rigid molecule plus a libration of approximately 5° about the three molecular axes. Each fluorine atom makes eight intermolecular contacts with other fluorine atoms and one close approach to another xenon atom. (auth)

5334 THE CRYSTAL STRUCTURE OF $XeF_2 \cdot XeF_4$ BY X-RAY DIFFRACTION. John H. Burns, R. D. Ellison, and Henri A. Levy (Oak Ridge National Lab., Tenn.). p.226-8 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A previously described xenon fluoride called the high-density form of XeF_4 was determined by crystal structure

to be a new compound $XeF_2 \cdot XeF_4$. The crystal data were found to be a = 6.64, b = 7.33, and c = 6.40 A, $\beta = 92°40'$, the probable space group, $P2_1/c$, and the arrangement of Xe atoms as a face-centered array. Two XeF_2 molecules were found to be centered in positions 2(a): 0, 0, 0; 0, $\frac{1}{2}$, $\frac{1}{2}$ and two XeF_4 molecules centered in positions 2(d): $\frac{1}{2}$, 0, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, 0. Intermolecular fluorine-to-xenon contacts of 3.28, 3.35, 3.35, 3.37, and 3.42 A were found in $XeF_2 \cdot XeF_4$. Therefore, the phase is appropriately described as a molecular addition compound. (P.C.H.)

5335 AN ELECTRON-DIFFRACTION STUDY OF THE STRUCTURE OF GASEOUS XENON TETRAFLUORIDE. R. K. Bohn, K. Katada, J. V. Martinez, and S. H. Bauer (Cornell Univ., Ithaca, N. Y.). p.238-42 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The structure of gaseous XeF_4 was determined by electron diffraction. The radial-distribution curve shows a principal peak at 1.94 Å corresponding to the Xe-F distance. The peak yields a root-mean-square amplitude of vibration of approximately 0.05 Å. In addition, the radial-distribution curve shows two other maxima at 2.77 and 3.88 Å. The peak at 3.88 Å is approximately $\frac{1}{5}$ that of the one at 2.77 Å. Approximating the peak at 2.77 Å with a gaussian curve yields a root-mean-square amplitude of vibration of 0.10 Å. The results show that gaseous xenon tetrafluoride is square planar to within experimental error. (P.C.H.)

5336 RADIATION DAMAGE IN XENON TETRAFLUORIDE, ELECTRON SPIN RESONANCE OF THE TRAPPED RADICAL XeF. W. E. Falconer and J. R. Morton (National Research Council of Canada, Ottawa). p.245-50 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

On γ irradiation of XeF_4 at 77° K the radical XeF is trapped in the crystal lattice. The electron spin resonance spectrum of XeF was interpreted, and it appears that the unpaired electron occupies an antibonding σ orbital of predominantly fluorine 2p- and xenon 5p-character. (auth)

5337 NUCLEAR MAGNETIC RESONANCE STUDIES OF XENON FLUORIDES. J. C. Hindman and A. Svirmickas (Argonne National Lab., Ill.). p.251-62 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Shielding values of 310, 482, and 612 ppm relative to gaseous fluorine were measured for the solid xenon hexafluoride, tetrafluoride, and difluoride, respectively. The shielding of XeF_6 shows little change in going from the vapor to the solid phase. XeF_4O, with a shielding constant of 326 ppm in the liquid phase, shows a doublet structure due to Xe^{129}-F^{19} coupling. The coupling constant is 1086 cycles per second. In hydrofluoric acid, XeF_6 undergoes exchange with the solvent. XeF_4 appears to dissolve without appreciable reaction with the solvent. A Xe^{129}-F^{19} coupling constant of 3860 cycles per second is found for this compound in HF media. Although XeF_2 undergoes exchange with the solvent at room temperature, the rate is sufficiently decreased on lowering the temperature to allow measurement of the Xe^{129}-F^{19} coupling. The observed coupling constant is 5600 cycles per second. Failure to observe any Xe^{131}-F^{19} coupling is consistent with the molecular symmetries of the solid compounds. The interpretation of the shielding data in terms of electron densities on the fluorine is discussed. Possible interpretations of the coupling constants in terms of bond configurations are also considered. (auth)

5338 HIGH-RESOLUTION MAGNETIC RESONANCE OF XENON COMPOUNDS. Thomas H. Brown, E. B. Whipple, and Peter H. Verdier (Union Carbide Corp., Tarrytown, N. Y.). p.263-9 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Studies were made on the magnetic resonance spectra of XeF_2, XeF_4, $XeOF_4$, and XeF_6 dissolved in anhydrous HF. At room temperature, solutions of XeF_4 and $XeOF_4$ show resolved fluorine spectra, while those of XeF_2 and XeF_6 show a single fluorine resonance, indicating chemical exchange with the solvent. On cooling, a resolved fluorine spectrum is obtained from XeF_2. The resolved fluorine spectra all consist of symmetrical three-line patterns plus the strong solvent line, illustrated by the XeF_2 spectrum at 56.442 mc. Qualitatively similar spectra are obtained at 15.000 mc. Separation of the weak outer lines is found to be independent of the magnetic field, while the separation of the center of the three-line pattern from the HF^{19} resonance is proportional to magnetic field. Application of a second radiofrequency field at one of the Xe^{129} resonance frequencies perturbs the satellite F^{19} lines, demonstrating conclusively that they result from the bonding of fluorine to Xe^{129}. (P.C.H.)

5339 HYDROGEN FLUORIDE SOLUTIONS CONTAINING XENON DIFLUORIDE, XENON TETRAFLUORIDE, AND XENON HEXAFLUORIDE. H. H. Hyman and L. A. Quarterman (Argonne National Lab., Ill.). p.275-8 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Xenon difluoride and hexafluoride were found to be very soluble at room temperature in anhydrous hydrogen fluoride, while xenon tetrafluoride is only sparingly soluble. Xenon difluoride appears to undergo no reaction or ionization solution. Xenon hexafluoride, on the other hand, is very soluble in anhydrous hydrogen fluoride; furthermore, the solutions are electrically conducting. Solutions containing XeF_6 are yellow liquids, comparable in color to liquid XeF_6. The color disappears on cooling. (P.C.H.)

5340 THE MÖSSBAUER EFFECT IN CHEMICAL COMPOUNDS OF Xe^{129}. G. J. Perlow, C. E. Johnson, and M. R. Perlow (Argonne National Lab., Ill.). p.279-83 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Measurements on Mössbauer effect were made with the 40.0 kev $\frac{3}{2}^+ \rightarrow \frac{1}{2}^+$ transition in Xe^{129}, which follows the β decay of I^{129} (1.6×10^7 y). Measurements were made on hydroquinone clathrate containing 28% Xe by weight, sodium perxenate (nominally $Na_4XeO_6 \cdot 2H_2O$), XeF_4, and XeF_2. The clathrate and perxenate show a single line unshifted from zero velocity within experimental error. Both XeF_4 and XeF_2 show large and equal quadrupole splittings. No isomer shift was observed for either of them. All data were fitted and errors determined by the method of least squares. In both XeF_2 and XeF_4, it was difficult to find a large enough source of the field gradient. (P.C.H.)

5341 MÖSSBAUER EFFECT IN KRYPTON. Stanley L. Ruby (Westinghouse Electric Corp., Pittsburgh). p.284-6 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Properties of Kr, which made it suitable for studies on Mössbauer effect, are discussed. (P.C.H.)

5342 RÉSUMÉ ON VIBRATIONAL SPECTRA OF XENON COMPOUNDS. H. H. Claassen (Argonne National Lab., Ill.). p.304-5 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Results of experiments on the infrared and Raman spectra of XeF_2, XeF_4, XeF_6, and $XeOF_4$ are discussed. (P.C.H.)

5343 THEORY OF BINDING IN INERT-GAS MOLECULES. Leland C. Allen (Princeton Univ., N. J.). p.317-28 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A many-electron theory for binding in inert-gas molecules is formulated and discussed. The importance of instantaneous electron-electron correlation in specifying the relationship between the periodic table and molecular formation is pointed out. A survey of other theoretical efforts and their relation to the present is also included. (auth)

5344 BINDING IN RARE-GAS COMPOUNDS. H. H. Michels (United Aircraft Corp., East Hartford, Conn.). p.329-32 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The relative importance of the various electron-correlation effects that occur in atomic and molecular systems of rare gases is examined. Special attention is given to radial-correlation effects between antiparallel electron pairs. (P.C.H.)

5345 THE NOBLE-GAS FLUORIDES, OXYFLUORIDES, AND OXIDES PREDICTIONS OF MOLECULAR SHAPES AND BOND LENGTHS. R. J. Gillespie (McMaster Univ., Hamilton, Ont.). p.333-9 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

It is shown how the shapes of known and as yet unknown rare gas compounds may be predicted and how, by comparison with the interhalogen compounds, the bond lengths in the molecules may also be estimated. The basic assumption of the theory is that the bonds in the molecules are essentially localized electron-pair bonds whose arrangement in space is determined by the mutual interactions of all the electron pairs in the valence shell of the central atom. Lone pairs exert greater repulsions than single-bond pairs, and oxygen atoms are assumed to be bonded by double bonds containing two electron pairs, which also exert greater repulsions than single-bond electron pairs. (P.C.H.)

5346 IONIC OR D-HYBRID BONDS IN NOBLE-GAS HALIDES. Juergen Hinze and Kenneth S. Pitzer (Rice Univ., Houston, Tex.). p.340-6 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

Discussion is presented on bonding in rare gas halides: one theory describes the bonds as covalent involving d hybrids, while the other describes them as half ionic without d hybridization. The results of computations show that the principal contribution to the bonding arises from ionic character and not from d hybridization. However, it is pointed out that large changes in the numbers, ionic and d contribution, may result if different approximations are used in the calculations. In similar computations, not including overlap, the ionic contributions were found to be lower by approximately ¼, while a d contribution twice as large was obtained. On the other hand, the average dissociation energies varied little in different calculations. In both computations the fluorides of argon and neon as well as the chlorides or bromides of all inert gases appeared unstable. (P.C.H.)

5347 AN LCAO-MO STUDY OF RARE-GAS FLUORIDES. L. L. Lohr, Jr., and William N. Lipscomb (Harvard Univ., Cambridge, Mass.). p.347-53 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The electronic structures of ArF_4, KrF_4, XeF_2, XeF_4, and XeF_6 are considered as a function of molecular geometry in terms of a programmed semi-empirical LCAO molecular-orbital theory. (auth)

5348 A SEMI-EMPIRICAL MO TREATMENT OF THE ELECTRONIC STRUCTURE OF XENON HEXAFLUORIDE. Edward A. Boudreaux (Louisiana State Univ., New Orleans). p.354-7 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

The electronic structure of XeF_6 is treated according to the Wolfsberg-Helmholz procedure in an attempt to find a reasonable scheme for the electronic distribution and to identify the lowest electronic excited state. (P.C.H.)

5349 THEORETICAL AND EXPERIMENTAL STUDIES OF THE ELECTRONIC STRUCTURE OF THE XENON FLUORIDES. Joshua Jortner, E. Guy Wilson, and Stuart A. Rice (Univ. of Chicago). p.358-90 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963.

A semi-empirical molecular-orbital model for XeF_2 and XeF_4 is presented. The results of experiments to determine the absorption spectrum in the range 1100–2500 A and determinations of the heat of sublimation of the compounds are described. The proposed model is shown to be in good agreement with the physical and chemical properties of the compounds. (auth)

5350 FERROMAGNETIC MATERIALS PREPARED FROM LANTHANONS AND TRANSITION METALS. William E. Wallace, Kurt Nassau, and Leonard V. Cherry (to Univ. of Pittsburgh). U. S. Patent 3,102,002. Aug. 27, 1963. Filed Mar. 25, 1960.

Compounds having empirical formulas AB_2 or AB_5 were prepared in which B was Mn, Fe, or Co and A was Dy, Ho, Er, Sm, Nd, Pr, Gd, Tb, or Y. The general method of preparation consisted of melting together weighed amounts of the components under an argon atmosphere. The magnetic properties and crystal structure of the compounds were studied, and data are presented in tables. Three ternary compounds were also prepared and studied: $Gd_{0.83}Y_{0.17}Co_5$, $Gd_{0.61}Y_{0.39}Co_5$, and $DyFe_{2.5}Ni_{2.5}$. (A.G.W.)

5351 NUCLEAR FUEL COMPOSITIONS AND METHOD OF MAKING THE SAME. Menahem Merlub-Sobel (to Curtiss-Wright Corp.). U. S. Patent 3,102,848. Sept. 3, 1963. Filed Nov. 23, 1959.

A process is described for preparing mixtures of uranium dioxide with Mo or W, in which the components are evenly distributed and intimately mixed on a molecular level. A soluble salt of U is reacted with a soluble salt of either W or Mo to form an insoluble salt containing U, O, and one of the other two metals. This compound is then reduced by a reducing agent that forms a volatile oxide. Examples of such reducing agents are hydrogen, hydrocarbons, and carbon. Uranium oxide is not reduced by such an agent; both W and Mo are reduced. Uranium salts of an acidic oxide such as uranyl nitrate are preferred as starting points, although uranium halides, uranyl halides, or other salts may be used. (A.G.W.)

5352 PRODUCTION OF RARE EARTH METALS. James H. Downing, Henry L. Gorski, and Ernest L. Koerner, Jr. (to Union Carbide Corp.). U. S. Patent 3,104,970. Sept. 24, 1963. Filed Feb. 16, 1961.

The process suggested for production of rare earth metals comprises preparing one rare earth oxide selected from the group consisting of Sm, Nd, Eu, Dy, Ho, Er, and Tm in admixture with a solid carbonaceous reducing agent and furnacing the mixture in vacuo. The composite charge is reduced, and the selected rare earth metal is distilled and collected on condenser surfaces. Several volatilization and condensation steps may be required. The same process may also be applied to mixtures of Sm_2O_3 and at least one rare-earth oxidic

material selected from the group consisting of Nd, La, Ce, and Pr. Graphite and resistor carbon are examples of useful reductants. Carbon may be used as a condenser surface, or Ta or Mo may be used if CO is not present in significant amounts. (A.G.W.)

5353 STABILIZED RARE EARTH OXIDES FOR A CONTROL ROD AND METHOD OF PREPARATION. R. A. McNees and R. A. Potter (to U. S. Atomic Energy Commission). U. S. Patent 3,117,372. Jan. 14, 1964.

A method is given for preparing mixed oxides of the formula MR_xO_{12} wherein M is tungsten or molybdenum and R is a rare earth in the group consisting of samarium, europium, dysprosium, and gadolinium and x is 4 to 5. Oxides of this formula, and particularly the europium-containing species, are useful as control rod material for water-cooled nuclear reactors owing to their stability, favorable nuclear properties, and resistance to hydration. These oxides may be utilized as a dispersion in a stainless-steel matrix. Preparation of these oxides is effected by blending tungsten oxide or molybdenum oxide with a rare earth oxide, compressing the mixture, and firing at an elevated temperature in an oxygen-containing atmosphere. (AEC)

Organic Chemistry

5354 (AEC-tr-6145) FLUOROPHOTOMETRIC INVESTIGATIONS OF LUCIGENIN OXIDATION REACTION. Jerzy Kroh and Zbigneiw Czerwik. Translated from Roczniki Chem., 31: 915-25(1957). 14p.

Changes in the fluorescence of lucigenin and its oxidation products, appearing during the process of chemiluminescence, were investigated. It was found that in the first stage of the lucigenin oxidation reaction there is a strong damping of the green fluorescence of the solution, which may be ascribed to the rapid accumulation of intermediate products. The process was found to be reversible. The spectra of the chemiluminescence and fluorescence of lucigenin exhibited considerable similarity. (M.C.G.)

5355 THE INFRARED SPECTRA OF TRIBUTYL PHOSPHATE CONTAINING EXTRACTED SALTS. Nobufusa Saito and Akira Yamasaki (Tokyo Univ.). Bull. Chem. Soc. Japan, 36: 1055(Aug. 1963).

The infrared spectra of TBP phases containing extracted chlorides, nitrates, and some inorganic complexes were studied. The results indicate that the phosphoryl band shift depends on the degree of solvation of the extracted salts in the TBP phase as well as on the nature and strength of the bond between the phosphoryl group and the salts. (P.C.H.)

5356 ELECTRIC DISCHARGE IN ETHANE IN THE PRESENCE OF TRITIUM. Bernard Louvat, Gérard Teller, and Jean-Pierre Adloff (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. France, No. 11, 2606-9 (1963). (In French)

The labeled products resulting from electric discharge in ethane in the presence of T are analyzed by gas-phase radiochromatography. A large fraction of the T is fixed in the ethane and in the products formed during the discharge. (tr-auth)

5357 AROMATIC SUBSTITUTION. PART V. THE MECHANISM OF THE REACTION OF PHENYLLITHIUM WITH PYRIDINES. DEUTERIUM ISOTOPE EFFECT STUDIES. R. A. Abramovitch and Choo-Seng Giam (Univ. of Saskatchewan, Saskatoon). Can. J. Chem., 41: 3127-31(Dec. 1963).

The ratios of isomers formed in the reaction of 3-alkylpyridines with phenyllithium under various conditions appeared to be invariant within the limits of experimental error. A number of experiments, including the reaction of phenyllithium with 3-picoline-2d and with an excess of a mixture of pyridine and pyridine-2d, are described, which establish that the hydride ion elimination stage in these nucleophilic aromatic substitutions is not important in determining the observed orientation and that the addition stage is either virtually irreversible or that the equilibrium lies far on the product side and is not rapidly reversible. A convenient procedure is described for working up the reaction mixtures. (auth)

5358 ISOTOPE EFFECTS IN THE METHYLENE INSERTION REACTION. I. PROPANE VS. 2,2-DIDEUTERIOPROPANE. John P. Chesick (Haverford Coll., Penna.) and M. Robert Willcott. J. Phys. Chem., 67: 2850-1(Dec. 1963).

Studies were made on the deuterium isotope effect in the insertion of methylene into the secondary carbon–hydrogen bonds of propane using the primary insertion reaction as an internal reference. The photolysis of propane-daizomethane mixtures was carried out using propane or 2,2-dideuteriopropane. In a series of seven runs the n-butane-isobutane ratio was 2.18 : 0.10. Three runs made with the 2,2-dideuteriopropane yielded the value of 3.0 : 0.15 for the n-butane-isobutane ratio. It was concluded that all n-butane observed in the runs made with deuterated propane must have originated in the insertion reaction. Primary-secondary insertion ratios of 3.0 and 2.45 indicate that methylene inserts in the secondary carbon–hydrogen bonds 1.23 times faster than in comparable carbon–deuterium bonds. A deuterium isotope effect of 1.37 is calculated if the unscavenged n-butane-isobutane ratio is used for the runs with C_3H_8. However it is believed that the only significant radical attack is occurring at secondary CH bonds in the system, and that 1.23 is the preferred number for the isotope effect. The small magnitude of the isotope effect observed corroborates the previously held point of view that the insertion reaction is a very efficient reaction taking place with a near zero activation energy. (P.C.H.)

5359 TRITIUM-LABELED COMPOUNDS. IX. DETERMINATION OF ISOTOPE EFFECTS IN REACTIONS YIELDING WATER-t FROM NONVOLATILE REACTANTS. OXIDATION ALDOSES-1-t WITH IODINE. Horace S. Isbell and Lorna T. Sniegoski. J. Res. Natl. Bur. Std., 67A: 569-72(Nov.-Dec. 1963).

A convenient method is presented for estimating isotope effects in reactions that yield water-t. The water-t is separated by freeze-drying, and k^*/k is calculated from the extent of the reaction and the ratio of the radioactivity of the water-t to that of the initial reactant. Application of the method to the oxidation of aldoses-1-t at 25°C with iodine in alkaline solution gives values for k^*/k ranging from 0.12 to 0.17, with an average of 0.14. There are no significant differences in the values of k^*/k obtained for aldoses differing in configuration, or for pentoses and hexoses. The isotope effect corresponds to a ratio of one to seven for the respective rates of reaction of the labeled and unlabeled molecules. (auth)

5360 IMPURITIES IN COMMERCIALLY PREPARED TRITIATED FOLIC ACID. Sheldon P. Rothenberg and Ruben Garcia (New York Medical Coll., New York). Nature, 200: 922(Nov. 30, 1963).

A check on the purity of a commercially available triti-

ated folic acid, specified by the manufacturer to be 100% pure by dilution analysis and chromatography, revealed that only 50% of the radioactivity corresponded to the folic acid absorbent area on paper chromatograms. (C.H.)

Radiation Chemistry and Radiochemistry

5361 (CONF-117-31) GAMMA RADIATION INDUCED HOMOGENEOUS PHASE VINYL POLYMERIZATION: A NEW TECHNIQUE YIELDS NOVEL KINETIC DATA. D. J. Metz and C. L. Johnson (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 4p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The radioinduced polymerization of pure styrene was chosen to study the role of water in the processes. The styrene was distilled, dried over silica gel, collected in pre-baked glassware, degassed, and sealed off at less than 10^{-5} mm of Hg pressure. Data on the polymerization were compared to data for samples in which no great pains were taken to remove the last traces of water. It was found that purity and dryness lead to much higher rates of polymerization at all temperatures studied. (M.C.G.)

5362 (COO-275) INVESTIGATION OF THE EFFECTS OF IONIZING RADIATION ON SYNTHETIC DETERGENTS, SEWAGE COLLOIDAL CHARACTERISTICS AND SEWAGE SEDIMENTATION. Final Report. (Unidynamics. Div. of Universal Match Corp., St. Louis). Sept. 6, 1963. Contract AT(11-1)-905. 108p.

An investigation of the effects of ionizing radiation upon colloidal phenomena and upon the sedimentation of sewage was conducted. Gamma radiation doses as low as 1270 rad at a rate of 10.4 rad/min effected a 6% increase in the sedimentation of simulated sewages. A dose of 13,200 rad at a rate of 296 rad/min resulted in a sedimentation increase of 8%. Actual sewages were also investigated. Study of suspensions of a montmorillonite clay (bentonite) indicated that sedimentation was increased by 45% following exposure to a radiation dose of 110,000 rad. Study of dispersions of this clay indicated that irradiation had altered the "double layer" characteristics of the colloid. An investigation of the radiation effects upon synthetic detergents indicated that gamma radiation could eliminate detergent foaming through a degradation of the detergent molecular structure. Studies of alkyl benzene sulfonate indicated that doses of less than 10,000 rad destroyed 50% of the detergent in 14 ppm solution, and that 90,000 rad had destroyed 99% of the detergent. Calculations indicated a "G" value of 3 for 50% removal and 1 for 90% removal. An economic evaluation of the radiation effects observed thus far in the investigation indicated that ionizing radiation could be economically utilized with current sewage treatment practices at isotope costs of $0.10 per curie. (auth)

5363 (RTD-TDR-63-4106) RADIATION ACTIVATION OF PARA-ORTHO HYDROGEN CATALYSTS. Amos J. Leffler (Little (Arthur D.) Inc., Cambridge, Mass.). Aug. 1963. Contract AF33(657)-8878. 67p.

An investigation was carried out to determine whether improved catalysts for the para-ortho hydrogen conversion could be obtained by radiation. A series of catalysts was found that were as high as ten times more effective than a standard hydrated iron oxide catalyst at −78°C. Included in this series of catalysts were two that were radiation activated. As a result of this work an improved understanding of the catalytic mechanism was obtained. (auth)

5364 RADIATION MEASUREMENTS: COMPARISON OF RADIOLYSIS EFFECTS OF COBALT-60 GAMMA RAYS AND 3-6 Mev ELECTRONS ON NITRILE SYSTEMS. Gordon H. Miller and Joseph J. Martin (Univ. of Michigan, Ann Arbor). Ann. N. Y. Acad. Sci., 105: 627-50(Oct. 23, 1963).

Acetonitrile was irradiated with Co^{60} at 0.4 to 0.7 megarads per hr and in a linear accelerator at 3.5 to 4 Mev. Radiolysis product identities and yields were determined by a combination of infrared, low, and high mass, and nuclear magnetic resonance spectroscopy, by gas chromatography, and by CN analysis. Purified acetonitrile was found to make a satisfactory dosimeter over the range examined, 1×10^6 to 6.5×10^8 rads. The weight per cent yield of CN is an exponential function of total dose in megarads, as given by: $CN = (0.005)\ (Dose)^{0.8245}$. The principal gaseous products are H_2 (G = 0.58) and CH_4 (G = 0.63), with minor yields of NH_3, C_2H_6, C_2H_2, N_2, HCN, C_3H_8, and C_4H_{10}. Identified heavier products are C_2, C_3, and C_4 aliphatic nitriles, succinonitrile, malononitrile, and acetonitrile dimer (3-iminobutyronitrile). A complex polymer (G = 8) contains imine or amine and nitrile groups, the C-H-N proportions approach $(CH_3CN)_x$, and the measured CN yield used in dosimetry is largely contained in the polymer. The high instantaneous dose-rate electron beam was not significantly different in its action from gamma radiation, as judged by hydrogen and CN yields. (P.C.H.)

5365 THE SYNTHESIS OF POLYMETHYLENE FROM CARBON MONOXIDE AND HYDROGEN BY NEW RUTHENIUM CATALYSTS ACTIVE AT LOW TEMPERATURES. H. Pichler and B. Firnhaber (Institut fur Mineraloel and Kohleforschung, Karlsruhe, Ger.). Brennstoff-Chem., 44: 33-7(Feb. 1963). (In German)

Preparation procedures for conventional RuO_2 catalysts, for irradiated RuO_2 catalysts, and for nonirradiated RuO_4 catalysts, each suspended in nonane, are described. Irradiated RuO_2 catalysts were prepared by precipitation of RuO_2 from methanol, drying in air at 110°C, and γ irradiation in a Co^{60} cell at a dose rate of 4×10^5 r/hr. The melting point, molecular weight, viscosity, and other physical properties of alkanes obtained with the Ru catalysts at 138, 148, and 180°C and 1000 atmospheres are given. Alkanes obtained at 120 and 132°C contained Ru as a contaminant. This could be removed from the former product by autoclaving at 150°C and 200 atmospheres, but this procedure was ineffective for the reaction products obtained at 132°C. The m.p. of the products ranged from 59 to 134°C and corresponded with increasing viscosity. The relative efficiencies of the Ru catalysts measured at 132°C decreased with the autoclave pressure. The efficiency of nonirradiated RuO_4 was slightly less than that of the irradiated RuO_2, but both were much more susceptible to pressure effects as compared to untreated RuO_2. At 120°C irradiated RuO_2 was more efficient than either of the other forms at 132°C. The molecular weight of the alkanes formed decreased with progressive increase in the synthesis temperatures. It is suggested that this may reflect differences in velocity of chain formation and desorption of the products from the Ru catalysts. The physical properties of the polymethylenes formed by the procedures outlined are compared with those of polymethylenes obtained from diazomethane and polyethylene, and their possible reaction mechanisms are discussed. (BBB)

5366 THE RADIATION-INDUCED REACTIONS OF BENZENE WITH SULFUR AND SULFUR COMPOUNDS.

Wataru Ando, Ken'ichi Sugimoto, and Shigeru Oae (Radiation Center of Osaka Prefecture, Sakai and Osaka City University, Kitaku). Bull. Chem. Soc. Japan, 36: 893-7 (Aug. 1963).

The irradiation of a benzene solution of sulfur gave thiophenol, diphenyl disulfide, diphenyl sulfide, hydrogen sulfide, hydrogen, and some polymers. The formation of thiophenol and of hydrogen sulfide was considered to be initiated by the radiolysis of benzene, which gives phenyl and hydrogen radicals, which in turn combine with sulfur in succeeding steps. However, the thiophenol formed was oxidized to the disulfide as the radiation energy absorbed in benzene transfers to thiophenol. The effect of the initial concentration of thiophenol and of the radiation dose was measured. The relative stability of the S–H and C–S bond for radiation was about 1:200. The radiolysis of diphenyl disulfide or hydrogen sulfide in benzene were found to form thiophenol. In a kinetical study of the decomposition of thiophenol in benzene, 0.7 benzene molecule was excited by the 100 ev of gamma rays absorbed, while the ratio between the energy transfer to thiophenol from excited benzene and the deactivation of excited benzene itself was about 100 to 1. (P.C.H.)

5367 THE THERMAL ANNEALING OF PHOSPHORUS-32 FORMED BY THE NEUTRON IRRADIATION OF SEVERAL INORGANIC PHOSPHORUS COMPOUNDS. Hiroshi Baba, Kichizo Tanaka, and Kenji Yoshihara (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 36: 928-37(Aug. 1963).

Thermal annealing curves given from the chemically distributed P^{32} formed by neutron irradiation in a nuclear reactor were obtained by heating several orthophosphates, sodium pyrophosphate, and disodium hydrogen phosphite samples in crystal. The separation was accomplished by one-dimensional paper chromatography. The amounts of P^{32} in the chemical species different from the parent species decreased upon the heating of the salts, except in the case of sodium dihydrogen phosphite, whereas retention always increased. Analysis of thermal annealing curves obtained from the initial distribution of activation energies, showed that there was a difference between the thermal-annealing behavior of the polyphosphate fraction and that of the reduced species fraction. The activation energies of the polyphosphate fractions were in the range of 0.60 to 1.0 ev, but the pyrophosphate sample showed an exceptionally high value, 0.78 to 1.3 ev. Higher activation energy values were estimated for the annealing of the reduced species fraction than for those of the polyphosphate fractions. (P.C.H.)

5368 ENERGETICS AND MECHANISM OF HYDRONIUM ION FORMATION BY ELECTRON IMPACT. D. Van Raalte and A. G. Harrison (Univ. of Toronto). Can. J. Chem., 41: 3118-26(Dec. 1963).

The reactions leading to formation of the hydronium ion in the mass spectra of a number of alcohols and formate esters were elucidated through a study of appearance potentials and metastable transitions and by the use of deuterium labelling. The results lead to $\Delta H_f(H_3O^+) = 157 \pm 3$ kcal/mole corresponding to a proton affinity of the gaseous water molecule of 151 ± 3 kcal/mole. (auth)

5369 TRITIUM RECOIL LABELLING OF LITHIUM ALUMINUM HYDRIDE. Constanta Măntescu and Ana Genunche (Inst. of Atomic Physics, Bucharest). Can. J. Chem., 41: 3145-7(Dec. 1963).

An attempt was made to prepare $LiAlH_4$-t using the recoil tritium resulting from the $Li^6(n,\alpha)T$ nuclear reaction. Samples of 30 to 50 mg of $LiAlH_4$ sealed in quartz tubes were irradiated with an integral thermal neutron flux of 7.2×10^{15} to 7.5×10^{17} n/cm^2. The total amount of tritium introduced in the sample during irradiation was determined by measuring the activity of the hydrogen gas evolved on hydrolysis and pyrolysis. The possibility of tritiation of organic compounds by using $LiAlH_4$-t thus prepared was demonstrated. (M.C.G.)

5370 THE EFFECT OF THE METHOD OF IRRADIATION ON THE EFFICIENCY OF A RADIATION CONVERSION. N. P. Syrkus (Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 1185-8(Oct. 11, 1963). (In Russian)

The productivity of an irradiation unit depends on its size and geometry, γ-dose rate, radiation yield G, and the irradiation time. With a conveyor system, the radiation yield, G, is given as a function of the absorbed dose P by an equation of the following form: $G = KP^{-\epsilon}$. Here ϵ is a kinetic factor. The productivity of a spherical irradiator in g/hr is given by the expression: $Q_{sph.} = 3.73 \times 10^{-4} (10^{-3\epsilon})(4\pi)^{\epsilon}$ MK d$^{\epsilon}$ $\gamma^{1-\epsilon}$ $W_0^{1-\epsilon} \int_0^R \exp[-(1-\epsilon)\gamma\rho]\rho^{2\epsilon}\, d\rho$ r/hr. Here ϵ is the kinetic factor; M is the molecular weight of the product having a radiation yield G; d is the density of the irradiation system in g/cm^3; γ is the linear electron coefficient for the conversion of γ-quanta in cm^{-1}; R is the radius of the irradiator in cm; W_0 is in watts (with the efficiency of the source assumed equal to 1). The productivity $Q_{sph.}$ in g/hr is plotted as a function of R at various values of d and ϵ for 1.0 Mev γ-quanta at $W_0 = 10$ watts, M = 100, and $G = 10^3 (10)^{2\epsilon}$ $P^{-\epsilon}$. The maximum productivity can be estimated from the efficiency of the unit and the radiation yield G. The productivity of a cylindrical irradiator is also calculated. (TTT)

5371 AN INTERPRETATION OF THE RESONANCE ABSORPTION OF γ QUANTA BY A NUMBER OF COMPLEX IRON COMPOUNDS ON TAKING INTO ACCOUNT THE COVALENCY OF THE BONE AND INDUCTIVE EFFECTS. A. V. Ablov, I. B. Bersuker, and V. I. Gol'danskii (Inst. of Chemistry and Inst. of Chemical Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 1391-4 (Oct. 21, 1963). (In Russian)

Mössbauer spectra were obtained for three iron(II) complexes containing thiosemicarbazone diacetyloxime ($DTOH_2$) as an addend: [Fe $(DTOH_2)_2$] Cl_2 (I), [Fe $(DTOH)_2$] (II), and [Fe $(DTOMe)_2$] (III). The structural formulas of the compounds show that the environment in the direct vicinity of the iron atom is the same in all three compounds, and differs only in far-order changes. Two protons are removed from a NOH group on going from I to II, and two protons are removed from a NH group on going from I to III. The quadrupole splitting Δ and chemical shift δ are, however, different in the compounds, and the effect of far-order changes on the Mössbauer spectra can be evaluated only by a consideration of the molecular orbitals in the compounds. An expression is written for linear combinations of the atomic orbitals, and the electric field gradients q_I, q_{II}, and q_{III} are calculated for the three ion complexes. It is shown that $q_I > q_{II}$, and that $|q_I| < |q_{II}|$. In addition, $q_{II} < o$. Also, it is found that $q_{III} > q_I$, $|q_{III}| > q_I|$, and $q_{III} > o$. The changes in quadrupole splitting can be explained by the covalency of the bond, and by inductive effects on the central iron atom. The data show that the Mössbauer effect can be used to study the electronic binding structure in complex molecules. (TTT)

5372 RADIATION STABILITY OF ION-EXCHANGE RESINS. Ting-wu Chang. Hua Hseuh Tung Pao, No. 3, 26-36(1962).

An account is given of the results of investigation on the changes in properties (exchange ability (EA), acid number (AN), degree of swelling, and solubility) of various ion-exchange resins under the effect of radiation. Both dry resins and those swollen in various media were studied. The results were not uniform. Thus, EA and AN of dry resins decrease under the effect of radiation, whereas in swollen resins EA decreases and AN increases. Different ion-exchange resins have different stability in respect to the action of radiation; resins with cross-linked structure display greater stability. Changes in the properties are influenced by adsorbable ions; resins containing sodium ions are more stable than those containing hydrogen ions. Changes in the properties of various ion-exchange resins depending on radiation dose, physical state, and chemical structure are tabulated. (OTS)

5373 EFFECT OF GAMMA-RADIATION ON OPTICALLY ACTIVE ORGANIC COMPOUNDS. J. Radell and S. M. Dec (Frankford Arsenal, Philadelphia and Physics Lab., Materials Central, Wright-Patterson AFB, Ohio). Israel J. Chem., 1: 21-4(July 1963).

The gamma radiolysis of aqueous or absolute ethanolic solutions of fourteen different organic optically active compounds is reported. (auth)

5374 DIFFERENCES IN ELECTRON SPIN RESONANCE SPECTRA AND ANNEALING CHARACTERISTICS OF RADICALS PRODUCED IN POLYCRYSTALLINE AND GLASSY ALKYL IODIDES BY γ-RADIOLYSIS. Harold W. Fenrick, Stephen V. Filseth, Allen L. Hanson, and John E. Willard (Univ. of Wisconsin, Madison). J. Am. Chem. Soc., 85: 3731-2(Dec. 5, 1963). (TID-19570)

Electron spin resonance spectra of alkyl halides with Co^{60} γ-rays at 77°K indicate that the nature of the detectable species formed, the yields of these species, and the annealing behavior at 77°K and on warming are often much different for the glassy form than for the polycrystalline form. Several of the polycrystalline alkyl iodides give complex spectra of 15 lines or more, that for ethyl iodide containing 30 lines with a spread of 1000 gauss. Results of an exploratory survey of the radiolytic yields of the stable organic products of ethyl halides down to 4.2°K are reported. (auth)

5375 REACTIVITIES OF THE PRIMARY REDUCING SPECIES FORMED IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. A. Appleby, G. Scholes, and M. Simic (The University, Newcastle upon Tyne, Eng.). J. Am. Chem. Soc., 85: 3891-2(Dec. 5, 1963).

The relative rates of reaction of $(H_2O)^-$ and hydrogen atoms, H^α, formed in the radiolysis of aqueous solutions toward different solutes are reported. Solutions of N_2O were used. Data are tabulated. (P.C.H.)

5376 EFFECT OF COBALT-60 γ RADIATION ON ACETYLACETONE. Maurice Paul Rutbi and Jean-Pierre Adloff (Nuclear Research Center, Strasbourg). J. Chim. Phys., 60: 1155-60(Oct. 1963). (In French)

The products formed during the irradiation of acetylacetone by Co^{60} γ radiation were determined by chromatography in the gaseous phase. Acetylacetone is more stable with respect to radiation than the aliphatic ketones already studied. This radioresistance is attributed to the structure of the irradiated compound. (tr-auth)

5377 γ-RAY-INDUCED EMULSION POLYMERIZATION OF VINYL CHLORIDE. Ung-Ping Wang (Union Industrial Research Inst., Hsinchu, Taiwan). J. Chinese Chem. Soc. (Taiwan), 9: 195-206(Sept. 1962).

Kinetics of polyvinyl chloride formation were studied in the irradiation (4×10^3 to 6.2×10^4 r/hr) at 25°C of the monomer in cyclohexanone with lauryl sulfate as emulsifier. The reaction proceeds in two stages, initiation and growth. In the first stage, polymerization of the monomer is initiated by free radicals and proceeds in emulsifier micelles, resulting in the formation of latex-like particles. No more particles are formed in the growth stage, but particles already formed continue to grow until the supply of monomer or free radical is exhausted. The effects of irradiation time and dose rate, emulsifier concentration, and vinyl chloride concentration were investigated. (BBB)

5378 THE RATE CONSTANTS FOR H ATOM REACTIONS IN AQUEOUS SOLUTIONS. J. K. Thomas (Argonne National Lab., Ill.). J. Phys. Chem., 67: 2593-5(Dec. 1963).

The irradiation of sulfuric acid solutions with and without added solutes was carried out under pulsed conditions on a linear accelerator and by steady continuous irradiation from a Van de Graaff accelerator. Yields of the products H_2, O_2, and H_2O_2 are interpreted in terms of the existing theory of the radiolysis of water, in terms of H atoms and OH radicals. Comparison of the results from the pulsed radiation with those obtained in the steady irradiation gives a means of evaluating the absolute rate constants for the various processes involved in the radiolysis of these solutions, in particular $kH + O_2 = 1.2 \times 10^{10}$; $kH + H_2O_2 = 4 \times 10^7$; $2kH + H = 1.2 \times 10^{10}$ $mole^{-1}$ sec^{-1}. A summary of the results of the analog computations is included. (auth)

5379 FORMATION OF THE HYDRATED ELECTRON IN THE FLASH PHOTOLYSIS OF AQUEOUS SOLUTIONS. Max S. Matheson, W. A. Mulac, and Joseph Rabani (Argonne National Lab., Ill.). J. Phys. Chem., 67: 2613-17(Dec. 1963).

In flash photolysis experiments with deaerated aqueous solutions of Cl^-, Br^-, I^-, OH^-, CNS^-, or $Fe(CN)_6^{4-}$ an absorption in the visible was observed. For several ions examined in detail the absorption was found to be a broad band similar to that recently observed in the pulsed radiolysis of aqueous systems and that was attributed to the hydrated electron. Suppression of the band by scavengers for e^-_{aq} confirms its identity. The results, in support of the interpretation of recent work in the steady-state photolysis of I^-_{aq}, show that the hydrated electron is an important intermediate in the photochemistry of many aqueous anion solutions. (auth)

5380 RADIOCARBON-LABELED COMPOUNDS PRODUCED BY THE NEUTRON IRRADIATION OF CRYSTALLINE UREA AND ACETAMIDE HYDROCHLORIDE. Thomas W. Lapp and Robert W. Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 67: 2688-91(Dec. 1963).

The nature and relative quantities of the radiocarbon-labeled compounds resulting from the pile-neutron irradiation of crystalline urea and acetamidine hydrochloride were investigated. Biuret and urea were found to contain 27 and 22%, respectively, of the total carbon-14 activity induced in the urea sample by neutron irradiation. The parent molecule, acetamidine, was found to contain 12% of the total carbon-14 activity induced in the acetamidine hydrochloride sample. In both studies, little activity was found in the form of simple compounds. Possible reaction mechanisms are suggested for the formation of the compounds containing appreciable percentages of the total activity. (auth)

5381 METAL ION SENSITIZED RADIOLYSIS OF ETHYLENEDIAMINE IN DILUTE AQUEOUS SOLUTIONS.

M. Anbar, R. A. Munoz, and P. Rona (Weizmann Inst. of Science, Rehovoth, Israel and Soreq Research Establishment, Rehovoth, Israel). J. Phys. Chem., 67: 2708-14 (Dec. 1963). (IA-850)

The radiolytically induced deamination of ethylenediamine in dilute aqueous solutions was investigated, using Co^{60} γ rays. In solutions of concentration up to 0.1M, the deamination is due primarily to the action of OH radicals. 2-Propanol and formic acid were shown to be much more reactive toward OH radicals and act as efficient scavengers. When the deamination was carried out under N_2O, evidence was found for the existence of N_2OH. On addition of thallous ions the deamination proceeds in the presence of overwhelming amounts of organic scavengers. The effect of thallous ions is nullified when strong complexing agents are added or when acidity is increased. A similar effect is observed when cupric ions are added; moreover, in this case it was shown that deamination is induced also by HO_2 radicals, which are otherwise nonreactive at the given range of concentrations. Other metal ions which form strong complexes with ethylenediamine but are not capable of reacting with OH or HO_2 radicals, by electron transfer; nickel, lead, and platinum, were shown to have no effect on the deamination process. It was demonstrated that metal ions, which may undergo fast reactions with the reactive species in radiolyzed water, will selectively induce radiolytic decomposition in their organic ligands. (auth)

5382 RADIOLYSIS OF LIQUID ETHYLENE. Richard A. Holroyd and Richard W. Fessenden (Mellon Inst., Pittsburgh). J. Phys. Chem., 67: 2743-50(Dec. 1963). (RRL-115)

The radiolysis of ethylene in the normal liquid temperature range, from −168 to −110°, is characterized by both radical and molecular processes. Butane, 1-hexene, and 1-butene (in part) are products that are formed by reactions of the radicals that were observed to be present in irradiated ethylene: ethyl, vinyl, and 3-butenyl. The yield of 1-hexene increases with temperature as a result of the addition reaction that forms 3-butenyl radical from vinyl radical, $C_2H_3 + C_2H_4 \rightarrow C_4H_7$ (reaction 1). At −165° $k_1/k_3^{1/2}$ is $\sim 4 \times 10^{-4}$ $M^{-1/2}$ $sec^{-1/2}$. $G_{C_2H_4}$ is approximately 0.9 and $G_{C_2H_6}$ is 1.7. There are molecular processes forming H_2, C_2H_2, dimer (C_4H_8), and trimer (C_6H_{12}). The dimers are identified as 1-butene and cyclobutane. The C_2H_4 intermediate species leading to cyclobutane may be either an excited state such as that formed by direct photolysis or the molecule ion providing it does not rearrange. The molecular trimerization reaction leads mainly to trans-2-hexene. The sum of the yields of all molecular products is greater than or equal to 2.1. (auth)

5383 ABSOLUTE RATE CONSTANTS FOR SOME HYDROGEN ATOM REACTIONS IN AQUEOUS SOLUTION. Harold A. Schwarz (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 67: 2827-30(Dec. 1963). (BNL-7254)

The effect of intensity on the radioinduced oxidation of deaerated ferrous sulfate solutions was studied using a 1.5-Mev electron beam produced by a Van de Graaff accelerator. The decrease in the yield of Fe(III) with increasing intensity is primarily due to a competition between the combination of hydrogen atoms to produce hydrogen and the oxidation of ferrous ion by hydrogen atoms. The Fe(III) yield at a given intensity and ferrous concentration increases when the length of the irradiation is very short (less than 10^{-4} sec). Absolute rate constants for the reactions are obtained from an interpretation of the pulsed-beam effect. It was found that $k_{H+Fe^{+3}} = 2 \times 10^{-7}$ M^{-1} sec^{-1} and $k_{H+H} = 1.5 \times 10^{10}$ M^{-1} sec^{-1}. (auth)

5384 CYCLOHEXADIENE FORMATION IN THE γ-RADIOLYSIS OF LIQUID BENZENE. Manfred K. Eberhardt (Mellon Inst., Pittsburgh). J. Phys. Chem., 67: 2856-7(Dec. 1963).

1,3- and 1,4-cyclohexadiene were identified in the gamma radiolysis of benzene. The G-values for the cyclohexadienes show a slight downward trend within the studied dose range (1.96×10^{20} ev/g to 17.65×10^{20} ev/g). The mechanism for the formation of the cyclohexadienes is discussed. The formation shows that benzene in the liquid phase reacts with hydrogen atoms by addition. (P.C.H.)

5385 PHOTOCHEMICAL AND RADIATION CHEMICAL REDUCTION OF CERIC ION IN AQUEOUS SULFURIC ACID SOLUTIONS. EFFECT OF FORMIC ACID. Thomas J. Sworski (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 2858-60(Dec. 1963).

The effects of formic acid on the photochemical reduction of ceric ion in H_2SO_4 solution was investigated to obtain evidence for the OH radical as an intermediate and for the reaction of OH radical with H_2SO_4. Initial quantum $\Phi(Ce^{+3})$ and $G(Ce^{+3})$ values were found to be markedly dependent on formic acid concentrations. $\Phi(Ce^{+3})$ decreases with increasing time of photolysis in all solutions due to the internal filter action of cerous ion and to reaction of cerous ion with OH radical. $G(Ce^{+3})$ decreases with increasing time of irradiation, the decrease being more marked during the first few minutes of irradiation. (P.C.H.)

5386 CARBON–CARBON BOND RUPTURE REACTIONS IN THE RADIOLYSIS OF 2,2,4-TRIMETHYLPENTANE. Tomoyoshi Kudo and Shoji Shida (Tokyo Inst. of Tech.). J. Phys. Chem., 67: 2871-3(Dec. 1963).

Initial G-values of H_2 and C_1-C_7 products form the radiolysis of 2,2,4-trimethylpentane (2,2,4-TMP) were measured. Scavenged and molecular yields of hydrogen, methane, propylene, isobutane, isobutene, heptanes, and heptenes were also obtained by adding iodine up to the saturated concentration. It was concluded that within the range of the products analyzed there should be four types of dissociation reactions in the radiolysis of 2,2,4-TMP. These reactions are discussed. (P.C.H.)

5387 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED SODIUM THIOSULFATE. Nobuyuki Goto (Ōita Univ., Japan) and On Matumura. J. Phys. Soc. Japan, 18: 1702-3(Nov. 1963).

The ESR spectra of a single crystal after Co^{60} gamma irradiation were measured at 3.2 cm wavelength for various crystal orientations in the magnetic field at room temperature. The dose rate was 10^5 r/hr and dosage from 10^4 to 10^7 r. (R.E.U.)

5388 ELECTRON SPIN RESONANCE STUDIES OF THE REACTION OF GASES WITH THE RADICALS FORMED IN IRRADIATED POLYTETRAFLUOROETHYLENE. Hisashi Ueda, Zenichiro Kuri, and Shoji Shida (Japanese Assn. for Radiation Research on Polymers, Tokyo). J. Polymer Sci., Pt. A, 1: 3537-45(Dec. 1963).

The effects of O_2, SO_2, NH_3, H_2S, and NO on the ESR of irradiated PTFE were studied. Radicals were produced by irradiation of PTFE in an atmosphere of one of the gases and by the postirradiation reaction of PTFE with the same gas. The radicals were subsequently reacted with each of the remaining four gases, and the resulting spectra were studied. The radical produced in PTFE by the irradiation in vacuum is quenched by NO. In this reaction, the relation between the number of quenched radicals

and the pressure of NO was measured, showing that the relation can be expressed by Freundlich's equation for adsorption equilibria. From the data, the bonds formed by the reaction between the gases and the radicals, the classification of the radical, and the structure of the radicals are discussed. (auth)

5389 STUDIES IN RADIATION POLYMERIZATION. J. W. Breitenbach, O. F. Olaj, and B. Wolf (Universität, Vienna). Monatsh. Chem., 94: 373-5(1963). (In German)

The monomers acrylonitrile, styrene, and vinyl acetate were irradiated with neutrons at 20°C for periods of 30 or 60 min at ~10 cm from a reactor core. Polymerization of acrylonitrile was about 25 times that of styrene, as contrasted to values of 60 or 80 times reported in the literature. Gelation effects prevented an estimate of polymerization of vinyl acetate under these conditions. However, following neutron irradiation at ~65 cm from the core for periods of 15 or 45 min at 21.5°C, the degree of polymerization of vinyl acetate was almost the same as that of acrylonitrile. This contrasts with literature values which indicate that polymerization of vinyl acetate is 10 times as great as that of acrylonitrile. Polymerization velocity of styrene is very marked. A molecular weight distribution was performed on a polystyrene fractionated in a Baker-Williams chamber. After γ irradiation at a distance of 33 cm from the reactor core for 4 hr at 31.5°C, conversion of the polystyrene amounted to 6.2% and its Staudinger index (in toluene) was 41.2 ml/g. The integrated mass distribution corresponded to a 75% fractional radical addition to the chain. It was concluded that the primary products that resulted from the radiochemical reaction have no specific breakage effect. Although the results of the styrene polymerization are not in complete agreement with those obtained with azoisobutyronitrile, they are close enough to suggest that the disruption mechanism is the same. (BBB)

5390 RADIOLYSIS OF ISOPRENOIDS. [PART I]. 2,6-DIMETHYLOCTANE. Wesley E. Shelberg and James F. Pestaner. [PART II]. 2,6-DIMETHYLOCTADIENE-2,6 AND SQUALENE. Wesley E. Shelberg, James F. Pestaner, and Richard Y. Yahiku (Naval Radiological Defense Lab., San Francisco). Nature, 200: 754-6(Nov. 23, 1963).

Radiolysis yields were determined for 2,6-dimethyloctane, 2,6-dimethyloctadiene-2,6, and squalene. In 2,6-dimethyloctane hot hydrogen atoms abstract hydrogen on their first collision with a neighbor molecule to produce hydrogen gas. The latter diffuse, react competitively with solvent and solute, and produce hydrogen gas by abstraction or self-combination. In some cases, an activated hydrogen molecule may detach a hydrogen molecule, leaving a biradical or olefin. Caged alkyl radicals from C–C bond scission recombine or disproportionate to a paraffin plus an olefin. Freely diffusing alkyl radicals combine to produce paraffins or disproportionate. It is postulated that molecules of 2,6-dimethyloctadiene-2,6 and squalene undergo C–H and C–C bond scission on radiolysis to produce hydrogen, methyl, and olefinic radicals. (P.C.H.)

5391 GAS YIELDS FROM ELECTRON-IRRADIATED COTTON CELLULOSE. F. L. Dalton, M. R. Houlton, and J. A. Sykes (Wantage Research Lab., Berks, Eng.). Nature, 200: 862-4(Nov. 30, 1963).

Results are reported from a study of the G value as a function of radiation dose of gases produced when cellulose was exposed in vacuum at ambient temperature to a radiation dose of 1.3 ± 0.02 M rad/min by means of a 4-Mev linear accelerator. Yield curves for CO, CO_2, and H showed that the gas was almost entirely H. Results indicate that the G value of H was dependent on total dose and that the reaction products depended critically on the efficiency of the outgassing of the cellulose. (C.H.)

5392 EFFECT OF GEOMETRICAL ISOMERISM ON THE BEHAVIOUR OF cis AND trans HEXAHYDROINDANES UNDER ELECTRON IMPACT. P. Natalis (Université, Liège). Nature, 200: 881(Nov. 30, 1963).

Observations on the behavior of cis and trans hexahydroindans under electron impact are reported. Emphasis was placed on the effect of geometrical isomerism on results. (C.H.)

5393 MANUFACTURING CHEMICALS BY IRRADIATION. David E. Harmer (Dow Chemical Co., Midland, Mich.). New Scientist, 20: 458-60(Nov. 21, 1963).

A method for the production of ethyl bromide using gamma rays from Co^{60} is described. (P.C.H.)

5394 ON THE CHEMICAL DISTRIBUTION OF P^{32} BY NEUTRON IRRADIATION. Hiroshi Baba (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 917-25(Nov. 1963).

The chemical distribution of P^{32} formed by neutron irradiation in a nuclear reactor was studied as a function of degree of hydration, number of acid hydrogen, and ionic radii of cations in various orthophosphates, sodium pyrophosphate, sodium phosphite, and sodium hypophosphite. The separation of chemical species containing P^{32} was done by paper partition chromatography. It was noticed that the chemical distribution of P^{32} was effected by hydrated water in target materials so as to increase the retention as parent form and to charge the stability of reduced species. As the discrepancies between retention values in a series of sodium orthophosphates were correlated to the number of acid hydrogen in samples, it was suggested that the effects were probably caused by the reducing action of acid hydrogen to the distributed species. On the effect of cations to the chemical distribution of P^{32} in irradiated tertiary phosphates, it was found that the percentage in each fraction was dependent upon ionic radii of cations. Three groups are shown in this case according to the valence states of cations. Each group was represented by one curve clearly different from others based on ionic radii of cations. The change of retention as parent form was proportional to the ionic radii of cations. (auth)

5395 ON RADICAL INITIATED CHAIN OXIDATION OF IRON(II) IN AIR SATURATED ACID SOLUTIONS CONTAINING ALCOHOLS. III. CHAIN PROCESSES IN GAMMA IRRADIATED SOLUTIONS CONTAINING C_2H_5OH. Lech Stolarczyk (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 391-4(1963).

The $G(Fe^{3+})$ values were measured in air-saturated aqueous solutions of 2.5×10^{-4} M Fe^{2+}, 0.4 M H_2SO_4, and 0.5 to 10×10^{-4} M C_2H_5OH after gamma irradiation. An inflection point on the curve of the relation between $G(Fe^{3+})$ and the concentration of C_2H_5OH was observed. The results are qualitatively explained as the competition between various chain mechanisms of iron oxidation and various possible chain breaking reactions. (auth)

5396 ON THE VARIOUS FORMS OF HYDROGEN ATOMS APPEARING IN THE GAMMA IRRADIATED AQUEOUS SOLUTIONS. Wlodzimierz Kolos (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 451-63(1963).

The ideas of the valence bond method were applied to the structure and stability of the hydrated electron and of

the hydrated H_2^+ ion. Several resonance structures of the system were considered and the energies of the structures estimated. It is shown that in aqueous solutions the unstable H_2O^- ion may be stabilized by delocalization of the unpaired electron. For the resulting hydration complex the weight of the structure representing a hydrated H_2^+ ion increases with increasing acidity of the solution. (auth)

5397 STRUCTURAL EFFECTS OF IONIZING RADIATION IN FERROELECTRIC ROCHELLE SALT. Henri Boutin (Brookhaven National Lab., Upton, N. Y.), B. C. Frazer, and Franco Jona. Phys. Chem. Solids, 24: 1341-7 (Nov. 1963). (BNL-7076)

Neutron diffraction measurements of the intensity variation of certain sensitive Bragg reflections with radiation dosage, established that the ferroelectric crystal structure of Rochelle salt is seriously affected by exposure to x rays and γ rays. Previously, the changes in the ferroelectric properties of this crystal were ascribed almost entirely to macrostructural changes, leading to hindered domain mobility. Also, optical studies threw new light on the differences in radiation effects in crystals irradiated within and outside the ferroelectric temperature range. In the first case, crystals irradiated to the point where hysteresis loops are no longer observable not only continued to show domain patterns in polarized light within the normally ferroelectric region, as was reported, but also showed domains at temperatures well outside of that range. On the other hand, crystals subjected to equivalent dosage at temperatures below the lower Curie point showed no domains at all, even in the middle of the normal ferroelectric temperature range. It is suggested that there are two basic types of damage that must be considered. One of these involves local damage centers, distributed more or less uniformly throughout the volume of the crystal, and producing structural effects at the unit cell level similar to those produced by introduction of impurity ions in the lattice. In the other case, previously existing imperfections (such as dislocations, e.g., but perhaps also including domain walls) become greatly reinforced by collection of diffusing damage products. The latter type introduces macroscopic clamping effects which hinder domain mobility and tend to stabilize the crystallographic phase existing during irradiation. (auth)

5398 SCINTILLATORS WITH POLYSTYRENE BASE FOR BETA DETECTION. I. F. Zubareva and Chung-wen Liu (Scientific Research Inst. for Agricultural Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 78-81(Sept.-Oct. 1963). (In Russian)

A method is proposed for the preparation of plastic scintillators with a polystyrene base and admixtures of paraterphenyl and 1,4-di-2(5-phenyoxazolyl) benzene (POPOP) for detecting β rays with high efficiency. The problem of using the scintillators for detecting low β activity and soft β emitters such as C^{14} is investigated. It is shown that the plastic scintillators can be used for the separation of two β emitters in a mixture. (tr-auth)

5399 THEORY OF DESTRUCTION OF LINEAR POLYMERS BY RADIATION. L. G. Gurvich. Tr. 2-go Vtorogo Vses. Soveshch. po Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, 516-20(1962).

It was assumed that the initial molecular weight distribution is arbitrary. The problem was to find the distribution f(M, D) where M is the molecular weight and D the dose. M is treated as continuous, which leads to appreciable errors only if M is much smaller than 10. The kinetic equation for f was solved with the aid of Laplace transformation. The value for f was computed for the case of all chains having initially the same length, for the most probable distribution, and for a Gaussian distribution. The strength of a polymer fiber is $F = \bar{f}\,[(\bar{M}_{20}/2\bar{M}_{n_0}) - 1/6\ KD\ (\bar{M}_{30}/\bar{M}_{n_0})] + \{\bar{F} - \bar{f}\,[(\bar{M}_{20}/2\bar{M}_{n_0}) - 1/6\ KD\ (\bar{M}_{30}/\bar{M}_{n_0})]\}\ \delta\ \{\bar{F} - \bar{f} - [(\bar{M}_{n_0}/2\bar{M}_{n_0}) - 1/6\ KD\ (M_{30}/M_{n_0})]\}$. For relatively small D, F decreases linearly, which agrees with experimental results. (OTS)

5400 ON THE MEASUREMENT OF THE LUMINESCENCE DECAY PERIOD OF CsI AND CsI(Tl) AFTER EXCITATION WITH LIGHT AND ALPHA PARTICLES. W. Rehmann, K. Reiber, and A. Scharmann (Universität, Gissen, Ger.). Z. Naturforsch., 18a: 1139-41(Oct. 1963). (In German)

The luminescence decay periods of CsI crystals with different Tl contents were determined. The crystals were excited with ultraviolet radiation and alpha particles. Effects of temperature were determined. Results are shown in graphs. (M.C.G.)

5401 THE GAS PHASE RADIOLYSIS OF ETHYL IODIDE. Ralph N. Schindler and M. H. J. Wijnen (Mellon Inst., Pittsburgh). Z. Physik. Chem. (Frankfurt), 38: 285-94(Sept. 1963). (RRL-108)

The decomposition of ethyl iodide in the gas phase resulting from bombardment with fast electrons was investigated. Part of the results can be explained on the basis of free radical reactions similar to those occurring in the gas phase photolysis of ethyl iodide. In addition, the formation of ethylene, acetylene, methane, hydrogen, and small amounts of vinyl iodide was found to occur by a molecular mechanism. The molecular processes account for roughly a third of all primary reactions observed. Single bond rupture in primary events yields the radicals C_2H_5, C_2H_4I, and CH_3 (together with their corresponding fragments) in the approximate ratio $1 : \geq 0.06 : 0.01$. (auth)

5402 KINETIC RELATIONS OF HYDROGEN PEROXIDE DECOMPOSITION ON γ-IRRADIATED AND NON-IRRADIATED LANTHANUM HYDROXIDE. Yu. S. Khodakov and Kh. M. Minachev (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 37: 2445-50(Nov. 1963). (In Russian)

Possible kinetic equations for the decomposition of hydrogen peroxide on the hydroxides of rare earth elements were derived. The rate constants, activation energies, and pre-exponential factors of the elementary stages of reaction were determined. It is shown that the limiting stage of the hydrogen peroxide decomposition is decomposition of the surface complex $K' \cdot H_2O_2 \cdot H_2O_2$, characterized by an activation energy of 24,000 cal/mole. It is also shown that γ irradiation of lanthanum hydroxide by Co^{60} in a dose of $1.7.10^9$ roentgens lowers the adsorption and chemical activity of lanthanum hydroxide with respect to hydrogen peroxide. The activation energies of the elementary stages of hydrogen peroxide decomposition on irradiated and non-irradiated lanthanum hydroxide are approximately identical. (P.C.H.)

5403 NOVEL NAPHTHAQUINOLS AND A PROCESS FOR THE MANUFACTURE THEREOF. Denis Haigh Marrian and Eustace Anthony Evans (to United Kingdom Atomic Energy Authority). British Patent 937,682. Sept. 25, 1963. Filed Feb. 13, 1961.

A process is described for manufacture of sodium salts of 2-methyl-naphthaquinol-(1,4) di(phosphoric acid) in which one or more of the four normal hydrogen atoms in the non-substituted ring are replaced by tritium. The process involves the reductive dehalogenation in aqueous solution of

2-methyl-naphthaquinol-(1,4) di(phosphoric acid) tetrasodium salts halogen-substituted in one or more of positions 5, 6, 7, and 8. Tritium gas is used in the presence of a hydrogenation catalyst that does not catalyze the removal of the phosphate radicals. The preferred monohalogeno starting materials are moniodo and monobromo compounds. The preferred polyhalogens starting materials are the polybromo compounds. Suitable catalysts are platinum oxide and mixtures of palladium and charcoal or palladium and calcium carbonate. An alkaline solution is preferred, and NaOH is a suitable basic agent. The reductive dehalogenation may be partially accomplished by tritium and completed with ordinary hydrogen. (A.G.W.)

5404 COPOLYMERS. Leo Philipp Ellinger (to British Oxygen Co. Ltd.). British Patent 938,355. Oct. 2, 1963. Filed June 13, 1960.

Copolymers containing both vinyl acetate and vinyl pyrrolidone are prepared by subjecting the mixed monomers, either alone, in solution, or in aqueous dispersion, to γ rays or high-voltage x rays. For polymerization in aqueous dispersion, the total dosage may be between 5×10^4 and 1×10^7 rads, but is preferably between 1×10^5 and 1×10^6 rads. Dose rates within the range 10^3 to 5×10^6 rads/hr may be used. Preferably the polymerization is carried out in an inert atmosphere and at a temperature within the range 10°C to the boiling point of the mixture at atmospheric pressure. If desired, the monomer mixture may contain a copolymerizable maleic ester. Addition of ammonia or amine before polymerizing lowers the molecular weight of the polymer. (A.G.W.)

5405 IRRADIATION DESTRUCTION OF COMPLEXES. John G. Erdman and James H. Wright (to Gulf Research and Development Co.). U. S. Patent 3,100,182. Aug. 6, 1963. Filed July 16, 1956.

A process is proposed for effectively reducing the porphyrin metallo complex content of mineral oils and other bitumens. The process involves subjecting the oil solution containing the complexes to high-energy ionizing radiation for a time sufficient to absorb between about 0.1 and 1000 megarads of energy. The porphyrin metallo complexes are destroyed by the radiation, and the oil and metal or metal-containing fragments may be separated by distillation, extraction, adsorption, or ion exchange. Metals existing in oil solution in this form and removable by this process include V, Ni, Fe, and Cu. (A.G.W.)

5406 PROCESS OF IMPROVING THE WEAR PROPERTIES OF A MINERAL AND FATTY OIL LUBRICANT MIXTURE BY RADIATION. Henry A. Ambrose and Charles E. Trautman (to Gulf Research and Development Co.). U. S. Patent 3,100,185. Aug. 6, 1963. Filed Dec. 28, 1959.

A process is proposed for improving the wear characteristics of a lubricating composition consisting largely of a mixture of a mineral oil and a fatty oil having an iodine value below about 100. The process consists of subjecting the mixture to ionizing radiation for a time sufficient for the mixture to absorb at least 24 and preferably 50 to 1000 megareps of radiation. During irradiation heat is removed at a rate sufficient to maintain the bulk temperature of the oil mixture below its decomposition or vaporization point. The lubricating composition can contain minor amounts of addition agents normally added to lubricating oils for a specific purpose, or it can be used as an additive to improve conventional lubricants. (A.G.W.)

5407 PROCESS FOR GRAFTING POLYMERS TO CELLULOSE SUBSTRATES. Robert William Hendricks (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,101,276. Aug. 20, 1963. Filed July 8, 1957.

An improvement in the polymer-grafting of cellulose substrates by irradiation techniques is proposed. The improvement comprises swelling the substrate by incorporating therein at least 15% by weight of a water-soluble, non-polymerizable swelling agent for cellulose, and thereafter subjecting the substrate to ionizing radiation. A polymerizable ethylenically unsaturated monomer is then applied to the substrate and is polymerized in situ as a result of the action of the radiation. The polymerizable monomer may be in contact with the substrate during irradiation or may be applied afterward. The swelling agent is preferably a liquid but may be a vapor. It may be water itself, a non-polymerizable water-soluble acid, base, or salt, or an organic system such as glycerol or $ZnCl_2$–methanol. A minimum exposure of 0.001 watt-sec/cm^2 to ionizing radiation of 0.75 to 5 Mev is necessary. The swelling agent may be subsequently removed with essentially no loss of the graftings. (A.G.W.)

5408 UTILIZATION OF PROTON RECOIL ENERGY IN NEUTRON IRRADIATED VAPOR PHASE ORGANIC REACTIONS. Frank T. Barr and Thomas A. Reiter (to Esso Research and Engineering Co.). U. S. Patent 3,101,307. Aug. 20, 1963. Filed Nov. 14, 1958.

A process is proposed for converting vaporous organic materials by absorption of energy from recoil protons. This process comprises maintaining in a reaction zone in a nuclear reactor spaced fixed fibers having a diameter of about 0.5 to 20μ and a high concentration of hydrogen nuclei. The reaction zone containing the fibers is exposed to irradiation by fast neutrons, and the vaporous organic material to be converted is passed through the reaction zone. The fast neutrons collide with the hydrogen nuclei of the fibers and create recoil protons. Because of the small diameter of the fibers, a major proportion of the recoil protons created pass into the organic vapors where their energy is absorbed. The organic vapors so irradiated are then withdrawn from the reaction zone and the desired product is recovered. The process can be applied to radioisomerizations of paraffin hydrocarbons, radioalkylation of paraffin hydrocarbons with olefins, radiopolymerizations, radiohydrogenations, and radiocracking reactions. (A.G.W.)

5409 IRRADIATED POLYMERS. Gaetano F. D'Alelio (to Dal Mon Research Co.). U. S. Patent 3,104,214. Sept. 17, 1963. Filed Nov. 14, 1957.

Fusible, soluble, self-extinguishing polymeric alkenyl aryl resins can be produced by irradiation of polymeric alkenyl aryl compounds contained in dilute solution with monochloro-polyfluoro compounds. About 1 to 30% by weight, preferably no more than 15%, of the polymer, based on combined weight of polymer and halide, is used. Irradiation with about 100 megareps from an energy source of at least about 100,000 ev should take place while the composition is substantially free from contact with free oxygen. Compositions used may also contain various agents such as plasticizers, lubricants, coloring agents, and fillers. (A.G.W.)

5410 IRRADIATION OF METAL OXIDES. Simon L. Ruskin, Carol Farhi, Dan B. Ruskin, and Milton Reder (to Union Carbide Corp.). U. S. Patent 3,104,216. Sept. 17, 1963. Filed Dec. 17, 1958.

Hydrous oxides may be produced by irradiating a mixture

of oxides in water with about 100 million roentgens at room temperature and pressure. A ceramic of high strength and abrasion resistance may be produced by irradiating a mixture of oxides with about 100 million roentgens heating the mixture to about 1600°C, and subsequently cooling the mixture to below about 1200°C. Oxides may be selected from oxides of Al, Si, Mg, Zr, Na, Fe, K, and Ga. The basic effect of high irradiation is the random rearrangement of crystals. Unusual properties resulting include capacity to act as semiconductors and an appearance resembling gems. (A.G.W.)

5411 SHORT LUMINESCENCE DELAY TIME PHOSPHORS. Charles W. Struck (to Radio Corp. of America). U. S. Patent 3,104,226. Sept. 17, 1963. Filed May 29, 1961.

The phosphors described are cerium-activated orthophosphates of at least one member of the group consisting of La, Y, and Lu. The mol ratio of Ce to La may be varied between 0.0001 and 0.10, but is preferably 0.01. The phosphors, when excited with cathode rays, emit ultraviolet light in the region of about 3400 Å and have a decay time in the order of 30 nsec. Examples of the preparation and use of the phosphors are given. (A.G.W.)

Separation Processes and Procedures

5412 (DP-809) PUREX PROCESS PERFORMANCE WITH SHORT-RESIDENCE CONTACTORS. Carl S. Schlea, Myron R. Caverly, Hugh E. Henry, and William J. Jenkins (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1963. Contract AT(07-2)-1. 32p.

Recovery and purification were satisfactory in miniature-pilot-plant tests of the Purex first cycle with the solvent residing four seconds in each extraction stage. Decontamination factors for both zirconium–niobium and ruthenium were greater than 10,000 with negligible crosscontamination of uranium and plutonium. The effects of the following on decontamination and plutonium partitioning were determined: irradiation level of the fuel, operating temperature, solvent saturation, accumulated exposure of the solvent, nitrous acid, and ferrous sulfamate versus U(IV) as a reductant for Pu(IV). (auth)

5413 (EUR-436.f) EXTRACTION DU PLUTONIUM(IV) PAR L'ACIDE DIBUTYLPHOSPHORIQUE. (Extraction of Plutonium(IV) by Dibutylphosphoric Acid). Ph. Dreze and G. Duyckaerts (Liège. Université). 1963. 50p.

The different parameters (acidity, nitrate, ionic strength), affecting the extraction of nitrate solutions of Pu(IV) by organic dibutylphosphoric acid solutions in benzene was studied. A mechanism is proposed for the extraction, at constant ionic strength, which takes into account the formation of nitrate complexes of Pu(IV) in the aqueous phase. The formula of the extracted species is $Pu(NO_3)_2(HA_2)_2$. (auth)

5414 (HW-72666) HOT SEMIWORKS STRONTIUM-90 RECOVERY PROGRAM. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 17, 1963. Contract AT(45-1)-1350. 179p.

The laboratory studies, radioactively cold development studies, and radioactively hot development-recovery activities involved in the Hot Semiworks operations leading to the recovery and purification of nearly a megacurie of Sr^{90} are described. The D2EHPA extraction process was used for separation of Sr^{90} from Purex plant crude Sr^{90} solution. Four runs, each processing 210 to 480 kC of Sr^{90}, were made, with each lasting about 2 weeks. A total of 744 kC of purified Sr^{90} was isolated for shipment out of a total input of 1180 kC. (M.C.G.)

5415 (IDO-14599) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, JULY–SEPTEMBER 1962. J. R. Bower, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 28, 1962. Contract AT(10-1)-205. 43p.

Aqueous zirconium fuel processing studies, directed at adapting the hydrofluoric acid process to continuous dissolution-complexing in order to increase the capacity of the ICPP process, resulted in two successful approaches to the complexing-feed adjustment step. Continuous in-line adjustment (conversion of uranium(IV) to uranium(VI) necessary for extraction) was accomplished in one minute or less at approximately 90°C; surges of dissolver product from the operating dissolver up to 1.9 times the flow sheet rate did not inhibit the oxidation of the uranium at this temperature. Batchwise mixing in air of dissolver product solution with complexer solution oxidized the uranium within two minutes at 23°C or higher. Further studies of continuous zirconium dissolution indicated that precipitation of uranium at the acid inlet can be a problem, probably because of local concentration gradients of free HF, which result in conditions of low uranium solubility. Control of dissolver acid composition by electrical conductance measurement appeared possible due to the linear relationship of conductance with acid concentration. Aluminum alloy dissolution rates in nitric acid were found to vary significantly, depending on the type and amount of alloying agent. Silicon, nickel, and copper in the alloy significantly decreased the dissolution rate. Batch dissolution times for standard test coupons ranged from 14 minutes for a high purity aluminum to 1400 minutes for an alloy containing 2.9 percent silicon. In the electrolytic dissolution of Nichrome in a bench-scale basket dissolver, the substitution of titanium for niobium as the anode basket material significantly reduced the contact resistance. Current interruption due to contact failure was essentially eliminated, and contact resistance on the titanium was sufficiently low that increasing solution resistance due to acid depletion became a major contributor to current decline as dissolution progressed. The indirect solution-contact electrolytic dissolution principle was further studied, producing data on electrode corrosion, power consumption, and gas generation on noble metal electrodes using both direct and alternating current. A second dual component analyzer, making use of density-conductivity measurements on the dissolver effluent, was shown to give an accurate measure of the acid and dissolved metal concentrations. Chemical-irradiation tests of insulating materials for use in electrolytic dissolvers were completed. Alumina ceramic was the only material tested that showed little or no change at dose levels of 10^{10} r; plastic materials with varying degrees of resistance are reported. Studies on waste treatment methods indicated the successful application of either ion exchange resins or locally available soil material to the removal of low concentrations of Cs^{137} and Sr^{90} from ICPP fuel storage basin effluent. The workability of a melt-freeze process for separation of aluminum nitrate from fission products, aimed at a 200-fold reduction in volume of ICPP generated wastes, was demonstrated in a single-stage laboratory unit. Pertinent solubility and density measurements were made and the operating diagram applicable to a multistage process is presented. Preliminary experiments on impregnation of calcined alumina with

molten sulfur appeared to be favorable from the standpoints of leach resistance, particle immobilization, and heat transfer. Operation of the Demonstrational Waste Calcining Facility further confirmed the applicability of process control methods developed in pilot plant operations to the DWCF, and demonstrated that these methods provide an ample degree of control over processing conditions. With this assurance of operability of the unit, plans are being made for a run spiked with radioactive Na^{24} as the next test. Key processing conditions, which were selected for this run, include operation at 400°C bed temperature, control to an amorphous bed, and return of the primary cyclone fines directly to storage with the bed product. Supplemental pilot plant and laboratory studies during the reporting period included tests of a wet spray return to control solids from the primary cyclone, demonstration of the control of particle size by addition of sand nuclei as an alternative to nozzle-air-ratio control, and completion of a study of the products of stainless steel and Nichrome nitrate calcination. Additional basic process studies made include methods of determining the amplitude and liquid level in an air-pulsed column, a method of securing flooding data for dynamic tests in pulse column control studies, and recommendations for control instrumentation on a uranium-salvage evaporator. High absorption efficiency of hydrous zirconium oxide for degradation products of tributyl phosphate was demonstrated. (auth)

5416 (IDO-14604) EVALUATION OF THE METAL-TO-METAL CONTACT BASKET-TYPE ELECTROLYTIC DISSOLVER. H. T. Hahn, J. R. Aylward, and M. R. Bomar (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). May 10, 1963. Contract AT(10-1)-205. 39p.

The performance of an electrolytic dissolver based upon the metal-metal contact principle was investigated. Interchangeable baskets of niobium, titanium, and titanium clad on the interior surface with platinum–10 percent rhodium were used. Other modifications such as inclination, a cone insert, a trough, and a tapered annulus were adopted with some success. Continuous operation was demonstrated at the 200-ampere level by promoting dissolution of the lowest element. The problem of discontinuity of operation which is encountered with a niobium basket was eliminated by the use of baskets made of titanium or lined with noble metal. Even with the latter materials, a gradually declining current occurs due to deteriorating contacts. Protection of the contact, as with a mercury pool, provides steady service, but this approach is limited by the inability to remove the heel from the protective layer. An analysis was made of the resistances encountered and an extrapolation of performance with full-scale elements attempted. For the conditions chosen, an average current of approximately 2000 amperes appears attainable in a full-scale dissolver. (auth)

5417 (ORNL-TM-687) PLASMA TORCH DESIGN AND DEVELOPMENT FOR NUCLEAR SAFETY PILOT PLANT OPERATION. P. P. Holz and C. M. Smith, Jr. (Oak Ridge National Lab., Tenn.). Dec. 20, 1963. Contract W-7405-eng-26. 27p.

A plasma torch was developed to effect the nonnuclear heating, oxidation, meltdown, and vaporization of irradiated fuel material. The irradiated fuel material to be melted is placed in a tantalum-lined boat and inserted by remotely controlled operations into a water-cooled furnace within a model containment vessel. Within the furnace, the fuel material is passed through the plasma arc produced by a torch unit installed on the top of the furnace. The rate of traverse of the fuel material through the arc and the torch current and gas flow can be controlled to achieve partial or complete melting during specified time intervals. The melting is optically observed via an Omniscope and television transmission to the control room. A modified torch is available with which to melt fuel material by powder-injection techniques. Use of this torch eliminates the need for the furnace and permits direct release of fission products into the model containment vessel. The torch can be installed at the wall of the vessel or in a simulated reactor core within the vessel. Other possible applications of the plasma-arc torch are suggested. (auth)

5418 (SRO-56) FISSION PRODUCT SEPARATION BY SOLVENT EXTRACTION. Final Report, April 1, 1959 to December 31, 1962. Robert J. Klett (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(38-1)-202. 296p.

Solvent extraction procedures for the chemical separation and purification of fission products were developed. Solvent extraction of the alkali metals and direct acid extraction were investigated. The extraction characteristics of the system including sodium and Group II metal ions extracting into D2EHPA were investigated over a wide range of concentrations at varying pH. The data are presented as distribution coefficients, phase concentrations, and equilibrium constants for 175 runs. Several methods of correlation based on the equilibrium concept were investigated for suitability for the system but none were found to be satisfactory. Data for direct extraction of mixed nitric and sulfuric acid by batch and stagewise contacts from pure acid solutions and simulated fission product waste streams are presented. The presence of salts tends to inhibit slightly the total acid extracted from a solution and very little, if any, of the sulfuric acid in the mixed acid solution is extracted until all of the nitric acid is extracted. (auth)

5419 (UVJ-890/63) FISSION PRODUCT RECOVERY SCHEMES. Václav Keurim (Ceskoslovenská Akademie Ved. Ustav Jaderného Výzkumu, Rez). Sept. 1963. 23p.

A selection is presented of integrated fission product recovery schemes published in the literature. The schemes are given in simplified form, several being complex (separation of pure nuclides) and others being relatively simple (recovery of cesium and strontium). (D.L.C.)

5420 THE ISOLATION OF CAESIUM-137 FROM LIQUID RADIOACTIVE FALL-OUT. J. Beneš and M. Kyrš (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Anal. Chim. Acta, 29: 564-8(Dec. 1963).

A method is suggested for the isolation of Cs^{137} from liquid radioactive fallout, suitable for the treatment of up to 1 liter of water in one batch. Cesium is coprecipitated with Prussian blue and dissolution of the precipitate in a saturated EDTA solution at pH 10, is followed by extraction of cesium as its dipicrylaminate, by nitrobenzene. (auth)

5421 ANION EXCHANGERS ON WOOD OR CELLULOSE BASES FOR DECONTAMINATION OF SURFACES AND LIQUIDS. O. Bobleter and K. Buchtela (Atominstitut der Osterreichischen Hochschulen, Vienna). Atomkernenergie, 8: 415-18(Nov. 1963). (In German)

Following reports in literature on the introduction of amine compounds into cellulose-containing substances, the production of anion exchangers by the reaction of wood materials with amines was systematically investigated. Especially suited is β-diethylamino-ethylchloride-hydrochloride, which was brought to reaction with sawdust at 100°C. The wood substances were pretreated with 17 to 20% NaOH.

Using this method very good exchange capacities of up to 1.2 mequ/g were obtained. By this same method it was also possible to produce strong anion exchange active papers on cellulose bases. Exchange materials from fine-grained sawdust can be used successfully for the decontamination of different types of surfaces. An apparatus for spraying cation exchanger suspensions was employed for the rapid and thorough decontamination of complicatedly built objects. Since it is usually not worth while regenerating the ion exchangers, which were charged, after liquid or surface decontamination, different possibilities of their further treatment were examined. The combustibility of the wood exchangers was proved to be advantageous, since it causes a great reduction of the original volume and therefore the waste storage costs are considerably reduced. (auth)

5422 THE PROCESSING OF REACTOR FUEL ELEMENTS. W. K. A. Walrave. Atoomenergie Haar Toepassingen, 5: 221-9(Nov. 1963). (In Dutch)

The composition of irradiated fuel elements, the fission cycle, and the processing of irradiated fuels are described. A description is given of the Noors-Nederlands testing installation at Kjeller. (tr-auth)

5423 TWO-STAGE FLOTATION TREATMENT OF URANIUM ORE FROM FARADAY URANIUM MINES LIMITED. W. R. Honeywell and V. F. Harrison. Can. Mining Met. Bull., 56: 610-14(1963).

Two series of laboratory flotation tests were carried out to study the treatment of Faraday ore by two-stage flotation. First the acid-consumers and then the uranium minerals were floated. On ore ground in the Faraday mill grinding circuit, and using Faraday mill water in the flotation step, a recovery in the flotation concentrate of from 91 to 93% of the uranium was obtained in 45 to 50% of the weight at a grade of 0.24% U_3O_8. The saving of acid in leaching the uranium-bearing flotation concentrate, as compared to leaching the whole ore, ranged from 30 to 46%. The average overall extraction resulting from flotation and leaching of the flotation concentrate was 88.1%. The best collector for the acid-consumers was sodium oleate. Acintol FA-1 emulsion was the best collector for the uranium minerals, and, in the uranium flotation step, an acid pH in the slurry was found to be necessary. The reagent costs were estimated to be 22 to 26 cents per ton of ore. (Atomdokumentation, Vol. 5, No. 19, Oct. 1963)

5424 THE EXTRACTION OF ACIDS BY BASIC ORGANIC SOLVENTS. II. TRIBUTYL PHOSPHATE-HYDROBROMIC ACID. D. C. Whitney and R. M. Diamond (Univ. of California, Berkeley). J. Phys. Chem., 67: 2583-7(Dec. 1963). (UCRL-10604)

An investigation was made of the extraction of hydrobromic acid from aqueous solutions into dilute solutions of tributyl phosphate (TBP) in CCl_4. The principal species that was found to extract over the range 1-10% TBP and 3-8M aqueous HBr concentration was $H_3O^+ \cdot 3TBP \cdot yH_2O \ldots Br^-$, with $0.2 \leq y \leq 1.0$; that is, only the trisolvated hydronium cation and bromide anion were observed. This is interpreted in terms of a proposed general model for such strong acid-basic solvent extraction systems. (auth)

5425 SEPARATION OF THORIUM BY USING FLUOBORIC ACID AS A PRECIPITANT. Kiyoshi Kudo (Telegraph and Telephone Public Corp., Ibaraki, Japan), Masumitsu Kubota, Yoshiaki Mimura, and Eiko Kodama. Nippon Kagaku Zasshi, 84: 632-5(1963). (In Japanese)

The precipitation of Th and its separation from a solution containing various metals using HBF_4 as a precipitant were investigated. Reactions of various metals with HBF_4 were examined. It was found that Th and rare earth elements were precipitated by HBF_4, but Zr(IV), U(VI), Sr, Fe(III), Ru(III), and Cs were not. Experiments on the precipitation of Th with HBF_4 were carried out under various conditions using Th^{234} as a tracer. The procedure was as follows: 5% HBF_4 solution was added to a Th solution containing Th^{234}. After 10 min, it was centrifuged. The precipitate was separated and dissolved in HNO_3 and H_3BO_3 mixture. An aliquot of the solution was pipetted and counted using a γ spectrometer. Th was recovered quantitatively in 2N HNO_3 containing 2.6 mg/ml of Th. It was found that addition of 5% HBF_4 solution and standing of the solution for 10 min were necessary conditions. Various metals such as Zr, U(VI), Ru(III), Sr, Fe(III), and Cs were not coprecipitated by this method. (P.C.H.)

5426 STRIPPING OF URANIUM FROM TRI-N-OCTYLOAMINE EXTRACTS BY SODIUM CARBONATE SOLUTIONS. Marek Golinski and Wincenty Korpak (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 395-400(1963). (In Polish)

Optimal parameters of uranium stripping from 0.1 M tri-n-octylamine(I) plus 3v% sec-n-octanol in kerosene were studied. Polish uranium ores were leached with 5% sulfuric acid and extracted with I. A 10% sodium carbonate solution was employed as the stripping agent. To obtain complete uranium stripping, it was necessary to supply to the system more sodium carbonate than stoichiometrically required. The phase separation depends on mixing conditions, extent of sodium carbonate concentration in aqueous phase, and ferric ion in organic phase. (auth)

5427 SEPARATION AND PURIFICATION OF Ag^{111}, Mo^{99}, Te^{132}, AND Cd^{115} IN FISSION PRODUCT MIXTURES. Marie-Claire Dupuis and Michel Dupuis (CEN, Fontenay-aux-Roses, France). Radiochim. Acta, 2: 4-6(Oct. 1963). (In French)

A method for rapid separation and determination of Ag^{111}, Cd^{115}, Mo^{99}, and Te^{132}, in fission products samples of very low activity was evolved from Dowex-2 anion exchange equilibrium studies on these elements in hydrochloric and nitric acids. After precipitation of Ag as AgCl, Te, Mo and Cd are adsorbed on Dowex-2 from 6M HCl and eluted sequentially. After additional purification, each element is mounted in source and counted. The chemical yield approximates 70% for silver, cadmium, and molybdenum and 95% for tellurium. The decontamination factor is 10^5 for most fission products. A set of four analyses can be performed in about eight hours. (auth)

5428 ON THE EFFECTS OF INERT DILUENT ON URANYL NITRATE EXTRACTION BY TRIBUTYLPHOSPHATE. A. A. Nemodruk and L. P. Glukhova. Zh. Neorgan. Khim., 8: 2618-23(Nov. 1963). (In Russian)

Effects of inert diluents on uranyl nitrate extraction by tributylphosphate were investigated. It was found that solutions of TBP in low-polarity diluent are capable of extracting uranyl nitrate with higher distribution coefficients than by simply diluted tributylphosphate. High polarity diluent produced an opposite effect due to stronger interpolar bonds inhibiting TBP reaction. (R.V.J.)

5429 ETHER REFINERY OF ST. LOUIS, MISSOURI—DESTREHAN STREET PLANT (Engineering Materials). (Mallinckrodt Chemical Works, St. Louis). (CAPE-52)

This package contains 49 drawings. The ether refinery process converts crude uranium ore concentrates to highly purified uranium trioxide (UO_3). Ore concentrates are first dissolved in nitric acid. Extraction of the resulting uranyl

nitrate from the digest liquor is accomplished in extraction columns with diethyl ether. The uranyl nitrate is then re-extracted from the ether into water. This water layer, containing virtually all the uranium, is freed from ether, concentrated, and the material put through a second ether extraction for further purification. The final steps in the process involve concentrating the highly purified water solution obtained from the second extraction, and then thermally denitrating in gas fired kettles. The UO_3 product is a bright orange powder. Auxiliary facilities include feed preparation, nitric acid recovery, raffinate treatment, ether recovery, and pulverizing, screening, and packaging of product. (R.E.D.)

5430 MIXER SETTLER, 16-STAGE (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1052)

This package contains 11 drawings. The in-line 16-stage mixer settler is a second modification of a mixer settler that was designed in Belgium. It was modified for use in the solvent extraction chemistry of transuranium and uranium elements. It is a laboratory scale instrument used where the flow rates are low. This modification retains the submerged weir between each settler and the downstream mixer. The weir balances the static head in the settler with an equal head on the downstream side, thus maintaining the aqueous-organic interface independent of mixer speed. The side, top, front, back plates, and weir are made of Homolite and are painted with Amercoat No. 33. Two gears are nylon, one gasket is Neoprene, and other parts are of stainless steel. The mixer settler is $20 \times 5 \times 6.75$ in. (F.S.)

5431 PURIFICATION OF URANIUM ORE CONCENTRATES. Robert V. Townend, Horace Q. Trout, and John E. Wilkalis (to Allied Chemical Corp.). U. S. Patent 3,100,681. Aug. 13, 1963. Filed Feb. 10, 1960.

A process for removal of undesired Na, V, and Mo from U ore concentrates obtained by soda leaching of the ore is described. In this process the concentrate is treated with an aqueous HNO_3 solution in sufficient amount to produce a slurry of pH ranging from its initial minimum point to about 0.5 thereabove. The U is dissolved and separated from the residue containing V. The resultant U-containing solution is then treated with sufficient aqueous NH_4OH solution to precipitate substantially all of the U, leaving Na in solution. The precipitate containing minimal quantities of Na and V and 95 to 97% of the U originally present is separated as product. When Mo is present in the original concentrate, it remains in the residue containing V. (A.G.W.)

5432 PRODUCTION OF LOW SULFATE URANIUM OXIDE. Andrew D. Kelmers (to Union Carbide Corp.). U. S. Patent 3,100,682. Aug. 13, 1963. Filed Apr. 15, 1960.

An improvement on the prior process of concentrating oxidic uranium from ores by solvent extraction is proposed. The improvement consists of decreasing the time of contact between the secondary liquor and the oxidic uranium precipitate formed by the addition of gaseous ammonia to the secondary liquor. When the rate of precipitation, thickening, and/or filtration is modified singly or in combination in such a manner as to decrease the total contact time to less than approximately one hour, the resulting oxidic uranium contains less than about 1 wt% residual sulfate. (A.G.W.)

5433 SOLVENT EXTRACTION PROCESS FOR THE RECOVERY OF URANIUM AND RARE EARTH METALS FROM AQUEOUS SOLUTIONS. Hamish Small (to The Dow Chemical Co.). U. S. Patent 3,102,782. Sept. 3, 1963. Filed Mar. 23, 1959.

In the proposed process an aqueous solution containing heavy metal values is brought into contact with discrete granules of a cross-linked insoluble alkenyl aromatic resin consisting essentially of a copolymer of a predominant amount of a monoalkenyl aromatic hydrocarbon and a minor proportion of a divinyl aromatic hydrocarbon having on the surface of the granules substituent hydrophile groups of the formula $-SO_3X$ where X represents a group consisting of hydrogen and a metal. The resin granules are swollen with an organic liquid comprising an organic water-immiscible complexing agent by which the heavy metal values are sorbed. The granules are separated from the metal-depleted aqueous waste solution, and the heavy-metal values are extracted by washing with water or an aqueous solution. (A.G.W.)

5434 PROCESS FOR SEPARATING SAMARIUM, EUROPIUM AND YTTERBIUM FROM OTHER RARE EARTHS. Maurice Leon Peltier and Paul Antoine Rombau (to Societe de Produits Chimiques des Terres Rares). U. S. Patent 3,102,783. Sept. 3, 1963. Priority date July 11, 1958, France.

A method is proposed for separating one or more of the elements, Sm, Eu, and Yb, from the other members of the group of rare earths with which they are associated. The Sm, Eu, and Yb present in a mixture can be reduced from the trivalent to the divalent state by known means. The mixture is then introduced into an ammonia solution wherein divalent rare earth compounds dissolve and can be separated from trivalent rare earths which form insoluble hydroxides. In another method SO_4 ions are added to the ammoniacal solution containing divalent and trivalent rare earth compounds to produce a precipitate containing insoluble sulfates of the divalent rare earths and insoluble hydroxides of the trivalent rare earths. When the solution is acidified slightly, the hydroxides dissolve and the insoluble sulfates can be separated. (A.G.W.)

5435 PRODUCTION AND SEPARATION OF MOLTEN CERIUM FROM ITS REDUCING METAL CHLORIDE WHICH IS IN SOLID FORM. William E. Domning (to The Dow Chemical Co.). U. S. Patent 3,104,166. Sept. 17, 1963. Filed Mar. 2, 1961.

To prepare molten Ce, cerium chloride is heated with a reductor metal, either Na or Ba, at about 400°C and under an inert atmosphere. Cerium chloride is reduced to Ce and the reductor metal is oxidized to its chloride. The reaction mixture is then heated to a temperature at which the Ce is molten but the chloride is solid, about 740 to 760°C, and the products are separated by filtration. The separated Ce is then heated to a temperature of at least 850°C at a pressure below about 0.1 mm Hg for at least 30 min to remove reductor metal chloride and unreacted reductor metal. (A.G.W.)

5436 PROCESS FOR THE SEPARATION OF THORIUM AND URANIUM SALTS. Kazimierz Josef Bril and Pawel Krumholz. U. S. Patent 3,104,940. Sept. 24, 1963. Priority date Sept. 2, 1958, Brazil.

A process is proposed for separation of Th from U in organic solutions in which both metals are present as nitrates. To the organic solution is added an aqueous solution of an agent that selectively precipitates the Th as a crystalline compound insoluble in, but transferred to, the aqueous phase. Free oxalic and sulfuric acid solutions are preferred as precipitating agents, but water-soluble salts of the acids may be used. Preferred con-

centrations of sulfuric acid and water-soluble sulfates are between about 1.5 and 2.5 M. For oxalic acid and water-soluble oxalate solutions, a concentration of between about 0.8 and 1.2 M is preferred. Recovery of Th with co-extraction of less than 1% of U present in the starting solution is possible. The process may be carried out continuously or batch-wise. (A.G.W.)

5437 PROCESS FOR PRECIPITATION OF URANIUM FROM SOLUTION. James L. Hart and Robert A. Koble (to Phillips Petroleum Co.). U. S. Patent 3,104,941. Sept. 24, 1963. Filed Oct. 26, 1959.

An improved process is described for precipitating U from a clarified pregnant liquor formed by leaching an ore with a carbonate leach solution. The precipitating agent, an alkali metal hydroxide, is added in two stages. The first addition substantially neutralizes the bicarbonate ions in the pregnant liquor. The second addition precipitates the U from the solution. Two automatic control loops are provided. The first loop controls the caustic addition in the first stage by measuring the pH of the admixture and adjusting the rate of addition. The second loop measures and controls the flow of both pregnant liquor and precipitating agent into a precipitation tank. (A.G.W.)

5438 PULSE COLUMN. Earl S. Grimmett (to U. S. Atomic Energy Commission). U. S. Patent 3,116,980. Jan. 7, 1964.

This patent covers a continuous countercurrent liquid-solids contactor column having a number of contactor states each comprising a perforated plate, a layer of balls, and a downcomer tube; a liquid-pulsing piston; and a solids discharger formed of a conical section at the bottom of the column, and a tubular extension on the lowest downcomer terminating in the conical section. Between the conical section and the downcomer extension is formed a small annular opening, through which solids fall coming through the perforated plate of the lowest contactor stage. This annular opening is small enough that the pressure drop thereacross is greater than the pressure drop upward through the lowest contactor stage. (AEC)

5439 ALUMINUM CLADDING DISSOLUTION. Wallace W. Schulz (to U. S. Atomic Energy Commission). U. S. Patent 3,119,658. Jan. 28, 1964.

This patent shows a method of moderating the chemical reaction when aluminum is dissolved in 2 to 7 molar nitric acid with a mercury catalyst. Nickelous nitrate is added as a negative promoter. (AEC)

ENGINEERING

General

Refer also to abstract 5845.

5440 (AD-423823) STRUCTURAL STABILITY OF TOROIDAL SHELLS: AN ANNOTATED BIBLIOGRAPHY. Peter R. Stromer, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). June 1963. Contract NOw 63-0050-C. 28p. (SB-63-50)

The toroidal shape is of particular interest in space applications as an optimum design for space vehicle liquid storage containers and for inflatable or collapsible structures. Torus designs have also been used by nuclear physicists to confine atomic fusion reactions in particle accelerators. Toroidal configurations are identified by their "donut" shape and have also been referred to as "anchor rings," "tore-shaped" shells, and in combination with spheres as torispherical shells. Both linear and nonlinear methods of stress analysis have been developed to study the structural stability of these shells; however, no reference to buckling behavior of toroids was located in this review of the literature covering the period January 1948 to June 1963. Fifty references are presented. A subject index is included. (auth)

5441 (JÜL-128-RG) UNTERSUCHUNGEN ZUR GRENZTRAGFÄHIGKEIT VON STAHLBETONPLATTEN. (Study on the Limiting Load-Bearing Capacity of Reinforced Concrete Plates). Thomas Jaeger (Kernforschungsanlage. Institut für Reaktorentwicklung, Jülich, Germany). 1963. 71p.

Thesis submitted to Technische Universität, Berlin.

The principles of the plastic limiting load-bearing capacity theory for reinforced plates are outlined for the case of simple proportional stress. An approximation method, the strain-break line or fracture line theory, is developed. The experimental program planned and carried out is described in detail, and the results are given. The test results obtained for rectangular concrete reinforced with soft steel and for square concrete isotropically reinforced with soft steel are compared with the solutions of the stress-fracture line theory. Test results are also reported for concrete plates reinforced with hard steel. (J.S.R.)

5442 EXPERIMENTAL TECHNIQUES IN SHOCK AND VIBRATION. Papers Presented at a Colloquium at the Winter Annual Meeting of the ASME, New York, November 27, 1962. Will J. Worley, ed. New York, The American Society of Mechanical Engineers, 1962. 143p.

Ten articles are included. One article on the measurement of physical effects from nuclear explosions was previously abstracted in NSA. The nine articles not abstracted in NSA include information on transient loading technique for mechanical impedance measurement, detection and measurement of stress waves, dynamic photoelasticity, role of dynamic models in a launch vehicle development, instrumentation for shock and vibration measurements, dynamic tests of buildings and special structures, techniques for simulation and analysis of shock and vibration environments of space flight systems, missile shock and vibration problems, and specification vibration testing. (P.C.H.)

Applications of Nuclear Explosions

5443 (SC-4602(RR)) PROJECT SCOOTER. Final Report. William R. Perret, Albert J. Chabai, Jack W. Reed, and Luke J. Vortman (Sandia Lab., Albuquerque, N. Mex.). Oct. 1963. Contract [AT(29-1)-789]. 168p.

Project Scooter was a cratering experiment devised as a part of the Plowshare study of large-scale explosions as excavation tools. The Scooter explosive was approximately one million pounds of TNT stacked in a spherical cavity centered at a depth of 125 feet in desert alluvium at Area 10 of the AEC Nevada Test Site. Results are presented of studies of crater dimension, throwout material distribution, ground motion, dust cloud growth, and long-range air blast. The crater produced by Scooter was 75 feet deep, had an average diameter of 307 feet, and a volume of nearly 100,000 cubic yards. Crater dimensions for chemical explosions up to a million pounds of TNT were found to fit overburden approximate scaling best. Fine particulate material ejected from the crater verified the empirical scaling law for ejecta derived from the Stagecoach experiments. Particle motion studies indicated a shock transmitted at a velocity of 4260 feet per second through desert alluvium. All measurements were at distances between 50 and 300 feet from the charge center and were shown to be within the region of nonlinear response of the soil. Surface particle velocities derived from photographic records served to derive expressions for crater radius stresses. Ground surface accelerations show a double peak, implying reaction first to ground shock and then to gas pressure. Maximum cloud height appears to scale as the fourth root of yield. Base surge propagated at an average velocity more than double the rate of base surge growth observed for the two shallower Stagecoach events. Long distance air-blast studies show that signals are ducted through the ozonosphere with higher transmission factors for larger yields. A high-speed jet stream affected strongly the signals ducted through the troposphere. (auth)

5444 (UCRL-6326) NUCLEAR EXPLOSIVES' POTENTIAL APPLICATIONS TO WATER RESOURCES DEVELOPMENT. J. Knox (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 7, 1961. Contract W-7405-eng-48. 16p.

Nuclear explosives have several intriguing potential applications to water resources development. Descriptions are given of the ways in which nuclear explosives could serve in the construction of a brine disposal system for the control of natural mineral pollution of streams, and in the construction of large ground-water recharge pits and/or surface reservoirs. In addition, preliminary cost estimates are given for the application of nuclear explosive techniques to the construction of (1) a brine disposal system, and (2) a ground-water recharge system. Comparisons are made with the cost of constructing equivalent systems by conventional methods. (auth)

5445 THE PEACEFUL USE OF NUCLEAR BOMBS. Theo Ginsburg (Technische Hochschule, Trondheim, Norway). Naturw. Rundschau, 16: 473-7(Dec. 1963). (In German)

The duality of the technology of nuclear weapons is discussed. Peaceful applications are emphasized. Project Plowshare is described. Obtaining electric energy from atomic bombs is discussed. Uses in obtaining coal and petroleum are outlined. Political aspects are discussed. (M.C.G.)

5446 METHOD FOR THE UTILIZATION OF ENERGY RELEASED BY A NUCLEAR EXPLOSION REACTION. William P. Drews, Hampton G. Cornell, and Andrew D. Suttle, Jr. (to Esso Research and Engineering Co.). German Patent 1,154,578. Sept. 19, 1963. Priority date Feb. 18, 1958, United States.

A method for introducing a nuclear-energy-generating device in a cavity in an isolated subterranean, compact, competent geological formation, preferably a salt formation, and detonating it is described. The energy liberated by the detonation is retained almost completely thermally adjacent to the zone of detonation for converting water introduced into the cavern into heated water or steam. The heated water or steam is withdrawn for use in an desired manner, for example in a power generating plant, heating plant, or oil recovery. (Gmelin Inst.)

Facilities and Equipment

5447 (CERN-63-36) TRANSFORMER COILS FOR HIGH MAGNETIC FIELDS. L. Hoffmann and V. Scheuing (European Organization for Nuclear Research, Geneva). Oct. 22, 1963. 30p.

Transformer coils with shaped single turnblocks as secondaries were investigated for pulsed magnetic field production. Principles of such coils are discussed, and their electrical characteristics are calculated. The gain of the field due to flux concentration and the special current distribution is examined, and experimental results obtained with model coils are discussed. (D.C.W.)

5448 THE CONSTRUCTION OF THE HOT AND ISOTOPE LABORATORY. P. Graf (EIR, Wurenlingen, Ger.), K. Metzger, and R. Stoehr. Neue Tech., 5: 490-7(Sept. 1963). (In German)

The basic principles to be followed in the construction of a hot laboratory are briefly indicated, and then the concepts used in the building of the Wurenlingen laboratory are given. The lay-out of the inactive, radiochemical, and hot cell sections are described. (J.S.R.)

5449 CONSTRUCTION AND BUILDING OF THE HOT CELLS. P. Graf (EIR, Wurenlingen, Ger.), P. Greter, M. Stauffer, and K. H. Suter. Neue Tech., 5: 497-503 (Sept. 1963). (In German)

The characteristics of the hot cells and the remote-control devices are discussed and shown in tabular form. The properties of the steel and heavy concrete used for cell construction and shielding are described. (J.S.R.)

5450 THE VENTILATION INSTALLATION OF THE HOT AND ISOTOPE LABORATORY. P. Graf (EIR, Wurenlingen, Ger.), W. Griner, F. Meier, Schaerer, and H. Studer. Neue Tech., 5: 509-20(Sept. 1963). (In German)

The functions of the ventilation and air conditioning systems are briefly tabulated, and their characteristics are given. The exhaust and input installations of the system are then described in detail for each of the three sections of the laboratory. The electropneumatic control and monitoring are described. A brief review of the special problems connected with the installation is given in conclusion. (J.S.R.)

5451 THE ELECTRICAL ENERGY SUPPLY OF THE HOT AND ISOTOPE LABORATORY. W. Griner (Eidgenossische Technische Hochschule, Zurich) and H. Studer. Neue Tech., 5: 536-7(Sept. 1963). (In German)

The requirements of the power supply for hot and isotope laboratories are briefly indicated. The characteristics and sources of the six power systems of the Wurenlingen laboratory are tabulated. (J.S.R.)

5452 REMOTE-CONTROL APPARATUS FOR THE INVESTIGATION OF IRRADIATED FUEL SAMPLES OF THE DRAGON HIGH-TEMPERATURE REACTOR. P. Graf, H. Lengweiler, H. Schumacher, and M. Stauffer (EIR, Wurenlingen, Ger.). Neue Tech., 5: 555-60(Sept. 1963). (In German)

Fuel samples of the Dragon high-temperature reactor are irradiated in the DIORIT reactor in the so-called capsule experiments. The processing sequence of the irradiated samples is tabulated and consists of mechanical disection, gas sampling, removal of the graphite capsule, dimension measurements, annealing, sample cutting, permeability measurements, and metallography. The remote-control apparatus used in each of these steps are described. (J.S.R.)

5453 EMISSION SPECTROGRAPH FACILITY—GLOVE BOX (Engineering Materials). (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). (CAPE-1038)

This package contains 25 drawings. The facility includes analytical equipment such as mass spectrometers, emission spectrographs, x-ray diffractometers, chromatographs, and flame photometers. Modifications to this facility, which consist of the addition of a lead-shielded cave or glove box and related utility services, are described. The glove box, which is located on a stand 38 in. high, is 59 in. long, 35.5 in. deep, and 31 in. high. It has 2 glove ports, 3 access ports, 2 viewing windows on the front, and an access door on the side. The box has 1.5-in.-thick lead shielding on the bottom, front, and sides, and 1-in.-thick lead shielding on the back and top. A centrifuge well 20.5-in. × 19.75 in. × 12.875 in. deep is located under the box. The well is shielded by 2 in. of lead on the front, bottom, and sides, and 1 in. of lead on the back. The filter housing and blower system used with the box are described. (F.S.)

5454 IMPROVEMENTS IN AND RELATING TO PRESSURE VESSELS. Linden Cyril Lamming (to Foster Wheeler Ltd.). British Patent 937,588. Sept. 25, 1963. Filed Aug. 23, 1961.

The pressure vessel described comprises a body part and a closure member joined together by means of bolts. A pair of rings is disposed between the two parts of the vessel so that as the bolts are tightened the rings are tightened one against the other to provide a good seal. The facing surfaces of the rings are grooved so as to define a toroidal chamber in which is disposed a flexible toroidal membrane the inside of which is in communication with the inside of the pressure vessel. On stretching of the bolts by pressure in the vessel, the rings are forced away from each other into intimate sealing contact with the two parts of the vessel while the membrane seals off the gap between the rings. Gaskets of soft metal may be arranged between two parts of the pressure vessel and the rings in order to achieve a good seal. (A.G.W.)

5455 IMPROVEMENTS IN OR RELATING TO THE SEPARATION OF SOLIDS AND GASES FROM MIXTURES THEREOF. James Elgie Lloyd and Joseph Raymond Mullarkey (to United Kingdom Atomic Energy Authority). British Patent 938,542. Oct. 2, 1963. Filed Nov. 13, 1959.

The apparatus described, for separating a solid in particulate form from a gas stream employed for transportation of the solid, comprises a container into which an inlet pipe extends upwardly through the base. The upper end of the pipe consists of a conically divergent section and a tubular cylindrical portion of larger diameter than the rest of the pipe. As the transporting gas stream flows upward in the tube and reaches the divergent portion, the velocity of the gas stream is reduced to a value at which transportation of the solid ceases. The particulate solid remains in the end of the tube in the form of a fluidized bed, and as the quantity increases, spills over into the base of the container. A gas outlet in the lid of the container and an inclined outlet pipe with a valve for solid are provided. (A.G.W.)

5456 GRIPPING DEVICE FOR CYLINDRICAL OBJECTS. James P. Pilger (to U. S. Atomic Energy Commission). U. S. Patent 3,118,698. Jan. 21, 1964.

A gripping device is designed for fragile cylindrical objects such as for drawing thin-walled tubes. The gripping is done by multiple jaw members held in position by two sets of slots, one defined by keystone-shaped extensions of the outer shell of the device and the other in a movable sleeve held slidably by the extensions. Forward movement of the sleeve advances the jaws, thereby exerting a controlled, radial pressure on the object being gripped. (AEC)

5457 CRYOGENIC DEWAR. William H. Chamberlain and Harvey E. Maseck (to U. S. Atomic Energy Commission). U. S. Patent 3,119,238. Jan. 28, 1964.

This patent relates to a dewar for storing cryogenic gases and is of the type having an inner flask surrounded by a vacuum jacket and having a vent spout through which evaporating gas escapes. Heretofore substantial gas loss has resulted from the radiation of heat towards the flask from the warmer outer elements of the dewar. In this invention, the flask is surrounded by a thermally conducting shield which is disposed in the vacuum space between the flask and the outer elements of the dewar. The shield contacts only the vent spout, which is cooled by the evaporating gas, and thus is maintained at a temperature very close to that of the flask itself. Accordingly, heat radiated toward the flask is intercepted and conducted to the evaporating gas rather than being re-radiated towards the flask. In a liquid helium dewar of typical configuration the invention reduces the boil-off rate by approximately one-half. (AEC)

5458 MULTIPLE DIFFERENTIAL ROTARY MECHANICAL DRIVE. Robert G. Smits (to U. S. Atomic Energy Commission). U. S. Patent 3,119,537. Jan. 28, 1964.

This patent relates to a mechanism suitable for such applications as driving two spaced-apart spools which carry a roll film strip under conditions where the film movement must be rapidly started, stopped, and reversed while maintaining a constant tension on the film. The basic drive is provided by a variable speed, reversible motor coupled to both spools through a first differential mechanism and driving both spools in the same direction. A second motor, providing a constant torque, is connected to the two spools through a second differential mechanism and is coupled to impart torque to one spool in a first direction and to the other spool in the reverse direction thus applying a constant tension to the film passing over the two spools irrespective of the speed or direction of rotation thereof. (AEC)

Heat Transfer and Fluid Flow

5459 (AEEW-R-134) THE SCALING OF FORCED CONVECTION BOILING HEAT TRANSFER. P. G. Barnett (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Jan. 1963. 40p.

A technique for obtaining scaling laws is presented which contains a new method of approach to non-dimensionalizing equations. This technique is used to obtain the exact scaling laws of forced convection boiling heat transfer as far as can be ascertained from present knowledge. By referring to the particular case of burnout under forced convection, arguments are presented which suggest that some of these scaling laws may be relaxed without unduly affecting the accuracy of a model. A possible set of scaling laws is deduced and a method of testing its validity is given. If this set of scaling laws should be found unsatisfactory the subsequent action is indicated. (auth)

5460 (AEEW-R-214) AN INVESTIGATION INTO THE VALIDITY OF CERTAIN HYPOTHESES IMPLIED BY VARIOUS BURNOUT CORRELATIONS. P. G. Barnett (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). June 1963. 55p.

Certain hypotheses implied by various burnout correlations are rigorously tested using the results of a series of experiments planned especially for this purpose. None of these hypotheses have previously been examined closely and all are found to be unacceptable when compared with the experimental evidence which has been carefully checked to ensure that it is self consistent. In particular, the hypothesis that channel length and diameter combine as a ratio, which is contained in the well known Bettis form of correlation, is shown to be invalid and to incur significant errors. On the other hand a new hypothesis, in which the burnout heat flux for uniformly heated tubes is assumed to be a function of channel diameter, pressure, mass velocity, and local burnout enthalpy, is found to be consistent with the experimental evidence. The new hypothesis, which involves only local conditions, is shown to provide a satisfactory basis for accurately correlating data and to achieve R.M.S. errors better than $5\frac{1}{2}\%$. (auth)

5461 (AEEW-R-222) BURN-OUT ANALYSIS. PART 3. THE LOW-VELOCITY BURN-OUT REGIME. Robert V. Macbeth (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Apr. 1963. 24p.

Extensive burnout data from Sweden was used to fully confirm the existence of a low-velocity, burn-out regime for water, and to determine accurately all its important characteristics. These include a precise (D G) and L/D effect on burnout, both of which are shown to apply to data with L/D ratios varying from 50 to 792 and pressures from 15 to 2000 psia. Examination of rectangular channel data confirmed that the basic burnout flux for a rectangular channel is linked with that for a round tube by a hydraulic diameter. For the single fluid considered, water, latent heat was found to dominate the pressure effect. This property adequately describes the burnout phenomenon for pressures greater than about 200 psia, although for lower pressures there is an additional weak pressure effect which can be allowed for by introducing two extra property groups in the burnout equation. These property groups correspond to the simplest of three sets of scaling laws considered. The boundary limits of the low-velocity regime were approxi-

mately defined and these show that the regime disappears at zero pressure and at the critical pressure, while at about 700 psia the regime extends to fairly high mass velocities, depending on the L/D ratio. The regime is extended by increasing the L/D ratio. A recommended burnout equation is presented for the low-velocity regime, which, applied to the whole of the round tube data from the literature, achieves an accuracy corresponding to less than 6% rms error. (auth)

5462 (AEEW-R-267) BURN-OUT ANALYSIS. PART 4. APPLICATION OF A LOCAL CONDITIONS HYPOTHESIS TO WORLD DATA FOR UNIFORMLY HEATED ROUND TUBES AND RECTANGULAR CHANNELS. Robert V. Macbeth (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England). Aug. 1963. 46p.

Burnout in uniformly heated round tubes and rectangular channels with liquid water inlet, can be correlated very accurately by a local-conditions hypothesis stating that burnout depends on the tube diameter or channel gap, mass velocity, pressure, and local enthalpy or steam fraction. The hypothesis is combined with the heat balance equation and with the near linear relationship that exists between burnout heat flux and inlet subcooling, to give a burnout equation that was optimised by a computer using all available World data. The high order of accuracy of the optimised burnout equation, and the very wide range of system parameters on which it is based, permit a thorough examination of parametric effects on burnout, which is not possible from inspection of data alone. Important observations are maxima in the effect of mass velocity and tube diameter on the burnout flux, and the existence of a pronounced peak at about 1,500 psia in the effect of pressure. (auth)

5463 (CEA-2283) INFLUENCE DES RUGOSITÉS DE PAROI SUR LES COEFFICIENTS D'ECHANGE THERMIQUE ET DE PERTE DE CHARGE. (The Effect of Surface Roughness on the Heat Exchange and Pressure-Drop Coefficients). Jean-Marie Malherbe (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1963. 64p.

The effect of various types of roughness on the wall of an axial tube in an annular space of 15 to 25 mm cooled by an air-flow was studied in the case of steady turbulence. Roughness for assurance of the boundary layers was set up using triangular threads of 0.2 to 0.4 mm thickness machined in the tube itself, or brass or glass wire wound on a smooth tube. Tests were also carried out using the roughness provided by regularly spaced pyramids 0.4 mm high. The results obtained showed that the heat exchange increased because of the presence of this roughness. A maximum in the heat exchange and pressure-drop coefficients was observed when the pitch equaled about eight times the height of the thread. An analytical method was developed and experiments were carried out in which the two walls of the annular space were heated in such a way as to transmit unequal heat flows. The region considered is limited to Reynolds' numbers of between 5×10^3 and wall temperatures of under 250°C. (auth)

5464 (GEAP-3899) BURNOUT CONDITIONS FOR SINGLE ROD IN ANNULAR GEOMETRY, WATER AT 600 TO 1400 PSIA. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 1963. Contract AT(04-3)-189. 159p.

Tests were run to determine burnout conditions for an electrically heated rod in a circular tube with an annular flow path for the upward water flow. The conditions correspond to those which might exist in a reactor core. The burnout results for the basic test geometry (straight concentric annulus) showed that a plot of burnout heat flux vs quality is a straight line with a negative slope, and that the burnout heat flux is increased by a decrease in flow or an increase in pressure, while the hydraulic diameter has a maximum effect on the flux at 0.25 to 0.5 inch. A correlation of the results is given for a certain range of conditions. The following modifications of the basic test geometry were also tested: eccentric rod, simulated spacer, sandblasted rod, and rough liner. The eccentric rod and sandblasted rod decreased the burnout heat flux, while the simulated space had no effect, and the flux for the rough liner is greater than for the smooth liner. The basic test geometry data are compared with other internally heated annular data and with multirod data. (D.L.C.)

5465 (NAA-SR-7534) FLOW CONTROLLER EVALUATION FOR SODIUM SERVICE. R. A. Winborne (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 30, 1963. Contract AT(11-1)-Gen-8. 36p.

Tests were conducted to evaluate the performance of a 10-in. flow controller in sodium at temperatures up to 1200°F. Torque tube reliability was determined by extensive mechanical cycling tests and further checking with a helium mass-spectrometer leak detector. Flow control performance and valve vibration characteristics were tested and evaluated and flow rate limits were established. The valve assembly was subjected to a thermal shock test program simulated to represent the most severe conditions likely to be encountered during a minimum 10-yr lifetime. (auth)

5466 (TID-19815) DEVELOPMENT LEADING TO AN IMPROVED DENSITOMETER FOR HELIUM–GRAPHITE OR NITROGEN–GRAPHITE FLOW STREAMS. Quarterly Report No. 189-21, May–July 1963. Donald H. Strobel (Badger Meter Mfg. Co., Milwaukee). Nov. 20, 1963. Contract AT(11-1)-1111. 7p.

An instrument is being developed for measuring the density of helium–graphite and/or nitrogen–graphite flow streams. The density meter is a closed-loop servo system using radioisotopes for the density sensing transducers. The unit will operate at temperatures to 600°F, pressures to 250 psi, flow velocities of 50 to 250 ft/sec, and graphite particle sizes of 1 to 2μ. After optimization of the various component values and time constants of the commutation circuits, long-term drift tests were conducted. Evaluation of the data indicated maximum drifts of ±1% of full scale. (M.C.G.)

5467 AN ACTION PRINCIPLE FOR MAGNETOHYDRODYNAMICS. M. G. Calkin (Univ. of British Columbia, Vancouver). Can. J. Phys., 41: 2241-51(Dec. 1963).

The equations of motion of an inviscid, infinitely conducting fluid in an electromagnetic field are transformed into a form suitable for an action principle. An action principle from which these equations may be derived is found. The conservation laws follow from invariance properties of the action. The space-time invariances lead to the conservation of momentum, energy, angular momentum, and center of mass, while the gage invariances lead to conservation of mass, a generalization of the Helmholtz vortex theorem of hydrodynamics, and the conservation of the volume integrals of $A \cdot B$ and $v \cdot B$, where A is the vector potential, B is the magnetic induction, and v is the fluid velocity. (auth)

5468 SLOW VISCOUS FLOW OF RAREFIED GASES THROUGH SHORT TUBES. Richard W. Hanks and Harold L. Weissberg (Oak Ridge Gaseous Diffusion Plant, Oak

Ridge, Tenn.). J. Appl. Phys. 35: 142-4(Jan. 1964). (TID-17883)

The semiempirical equation that was shown by Weissberg to be a very close approximation to the rigorous variational calculation of the pressure drop for creeping flow of incompressible viscous fluids through short tubes was generalized to take into account the slip of a rarefied gas at the tube wall. The generalized equation is $w = w_s + \beta a/\bar{\lambda}$, where a is the tube radius, $\bar{\lambda} = (\mu/\bar{P})(\frac{1}{2}\pi RT/M)^{1/2}$, and $w = F/[\frac{1}{4}\pi a^2 \Delta P(8RT/\pi M)^{1/2}]$. Here, μ and M are the viscosity and molecular weight of the gas, ΔP is the pressure drop $P_1 - P_2$, $\bar{P}$ is the average pressure $\frac{1}{2}(P_1 + P_2)$, R is the gas constant per mole, T is the absolute temperature, and $F = \bar{P}Q$ where Q is the volume flow. The coefficient β and the slip parameter w_s depend only on L/a, the length to radius ratio of the tube: $\beta = (\pi/8)/[(L/a) + (3\pi/8)]$, $w_s = (\beta^2/3\pi)[(128L/a) + (27\pi^2/4)]$. Excellent agreement is noted between values of w calculated from the equation and values obtained by Knudsen for long tubes and by Lund for short tubes. (auth)

5469 A RESEARCH ON CRITICAL THERMAL FLOW FOR ORGANIC LIQUIDS. L. Matteuzzi, A. Palmiere, and G. C. Pinchera. Termotecnica (Milan), 17: 577-82(1963).

A research program for the determination of the critical thermal flow under conditions of insufficient heating and for the study of nucleate boiling is described. The variables that must be considered are the coolant, supplementary materials, geometric parameters, and operating conditions. The properties of the test circuit are given. The instrumentation for the detection of burn-out and for the measurement of the other experimental magnitudes is described in some detail. (J.S.R.)

5470 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Peter Liptrot Riley, Derek Taylor, and Alexander Gilchrist Frame (to United Kingdom Atomic Energy Authority). British Patent 938,122. Oct. 2, 1963. Filed Apr. 6, 1961.

The heat exchanger described comprises a containment vessel, through which a heat transfer liquid is passed in circuit from a heat source, and banks of tubes in the vessel. The tubes are divided into two groups, one group for initial heating of a working fluid and the other for reheating of the working fluid. The number of banks of the first group is reduced at an overlap of the two groups by bends that bring the tubes of each of certain selected banks into the plane of an adjacent bank, and the banks of the second group extend in parallel planes to the first group within the spaces left vacant by the bending of the selected banks of the first group. When the heat transfer fluid is a liquid passed through the vessel in such a manner as to maintain a free surface therein, it is preferred that each tube is a single continuous length beneath the free surface level. (A.G.W.)

Materials Testing

Refer also to abstract 6473.

5471 IMPROVEMENTS IN OR RELATING TO LEAK TESTING OF NUCLEAR REACTOR FUEL ELEMENTS. Kenneth Miles Rose and Charles Alan Mann (to United Kingdom Atomic Energy Authority). British Patent 938,352. Oct. 2, 1963. Filed Aug. 1, 1961.

In the method described for leak testing a helium-filled nuclear reactor fuel element the fuel element is immersed in He to cause He to enter the sheath. The sheath is sealed, and the fuel element is transferred to a chamber filled with a gas other than He at a pressure such that, if there is a leak in the fuel element sheath, He can diffuse from the fuel element sheath through the leak into the chamber without desorption of He from the surface of the sheath. The gas in the chamber is then tested for He content without reducing the pressure of gas in the chamber below the pressure at which He desorbs from the surface of the fuel element sheath. A leak test chamber is described, which is connected to a mass spectrometer through an adjustable leak. (A.G.W.)

5472 RADIOGRAPHIC SYSTEMS AND METHOD. Thomas H. Rogers, Gordon F. Bavor, and Bror Magnusson (to The Machlett Labs., Inc.). U. S. Patent 3,103,591. Sept. 10, 1963. Filed Mar. 31, 1960.

An x-ray generator is described, which may be selectively operated in conventional radiographic systems or cineradiographic systems. A pulse-forming and -timing circuit for generating an essentially square voltage pulse is provided. A switching circuit built into the x-ray tube comprises an electric field-forming element that encircles the filament and, when the negative bias is applied, creates a negative field to prevent flow of electrons from filament to anode. The filament associated with the switching circuit produces a small focal spot of precisely controlled dimensions for use in cineradiography. A second filament in the same tube is separate from the switching means and selectively operable. It produces a large focal spot suitable for conventional radiography. (A.G.W.)

Protective Structures

5473 (ORNL-3499(Vol.I)(p.147-52)) ANALYSIS OF TSR-II RADIATION DISTRIBUTION IN VERTICAL CONCRETE-LINED CYLINDRICAL HOLES AND AN ADJOINING TUNNEL. M. B. Wells (Oak Ridge National Lab., Tenn.).

The fast-neutron and gamma dose rates within unshielded, vertical, concrete-lined, cylindrical holes at the Tower Shielding Facility were calculated in generally good agreement with measurements. A simple expression for the dose-rate albedo for scattering of fast neutrons from the concrete walls of the hole was obtained. (auth)

5474 (ORNL-3499(Vol.I)(p.153-5)) ANALYSIS OF TSR-II RADIATION DISTRIBUTION IN UNDERGROUND CONCRETE BUNKERS. R. L. French (Oak Ridge National Lab., Tenn.).

Fast-neutron dose rates in the bunkers were predicted by independent means to within 10% of the measured values in most cases. Gamma dose rates were predicted to within 10 to 16% of the measurements in the open-top bunker, but the predicted dose rates were about 20% too high for the open-front bunker. The only dependence upon the experimental data during the calculation was the use of the measured thermal-neutron fluxes in calculations of secondary gamma dose rates. (auth)

GEOLOGY AND MINERALOGY

General

5475 (UCRL-13010) INTERIM REPORT ON RESEARCH ON RADIOACTIVE CONTAMINATION OF GROUND-WATER AQUIFERS. First Annual Report. (Texas. Agricultural and Mechanical Coll., College Station. Research Foundation; Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station and California. Univ., Livermore. Lawrence Radiation Lab.). June 15, 1961. Contract W-7405-Eng-48. 51p.

Preliminary results are reported for studies of the rate of migration of tracer amounts of Sr^{90} through water-saturated quartz sand in vertical exchange columns and ion exchange measurements on Ottawa sand. A potentiometric model was developed for studying liquid flow in sand-packed columns that was based on the similarity of equations for liquid and electrical flow. Results are reported from applications of the model on two types of columns. (C.H.)

5476 THE AGES OF BOMA MIGMATITES AND OF THE WEST CONGOLIAN OROGENY. PRELIMINARY DATA ON THE AGES OF THE MAYUMBIAN AND AN EARLIER FORMATION. L. Cahen, J. Delhal, D. Ledent, and M. Reinharz. Ann. Soc. Geol. Belg., Bull., 86: B229-69(Aug. 1963). (EUR 450.f). (In French)

The oldest, (2760 ± 500) million years or older, is interpreted as representing an episode of an orogenic cycle, older than the Mayumbian orogeny. The next event, also only approximately dated between 1480 and 1800 million years is the Mayumbian orogeny. The last major event, of which a late tectonic phase is circa 615 million years old, is the West-Congolian orogeny which is followed by post-tectonic pegmatites and veins spanning the interval between 520 (pegmatites) to circa 445 (last veins) million years. Numerous biotites have, by both the Rb–Sr and the K–Ar method, yielded apparent ages similar to those of the last post-tectonic veins, though their true age be certainly older. This is also the case for a K–Ar age on microcline. These results indicate that these apparent ages on biotite and microcline are probably caused by a post-tectonic hydrothermal event and/or by the uplift which took place at the same time, after the West Congolian folding. It therefore follows that low Rb–Sr apparent ages on biotites are not necessarily caused by superimposed tectonics or by an important metamorphism. (auth)

5477 INTRODUCTION OF CHEMICAL ERRORS IN THE RADIOCARBON AGE CALCULATION. J. Leclipteur. Bull. Soc. Roy. Sci. Liege, 32: 680-7(1963). (In French)

In the radiocarbon dating method consideration is usually given to statistical measurement errors. However, the utilization of liquid scintillators for this study necessitates three measurements of the activity of a scintillating mixture and there can be no certainty of perfect reproducibility in the chemical processes of preparation. A method that introduces in the age calculation the variations of the scintillating qualities of the three mixtures is presented. (tr-auth)

Natural Radioactivity and Fallout

5478 (AERE-R-4392) RADIOACTIVE FALL-OUT IN AIR AND RAIN RESULTS TO THE MIDDLE OF 1963. R. S. Cambray, E. M. R. Fisher, G. S. Spicer, C. G. Wallace, and T. J. Webber (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England and United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Nov. 18, 1963. 31p.

Samples of atmospheric dust and rainwater were collected from the United Kingdom and overseas. Results are presented of the analyses of samples collected between April and August, 1963 for various fission products. As a consequence of continued weapons testing in 1962 the concentrations of the long-lived fission products Cs^{137} and Sr^{90} in air and rain over the United Kingdom increased in 1963 to levels that are twice those of 1962. Owing to greater rainfall in the late spring and summer months, the deposition of Cs^{137} and Sr^{90} at Milford Haven for the first six months of 1963 was almost three times that for the corresponding periods of 1959 and 1962. About 75% of the long-lived radioactivity in samples collected during 1963 is estimated to have originated from the weapons series of 1962. The new debris is mainly restricted to the northern hemisphere and is shown to be well mixed from the equator to 70°N. Integration over the world of the deposition of Sr^{90} in rain provides an estimate of the total global deposition to the end of 1962. The mean effective particle diameter of fallout debris in the lower atmosphere increased from 0.5μ in the period before the autumn of 1961 to about 1μ in January 1963 and has since, in the summer of 1963, approached its former value. (auth)

5479 (RISÖ-63) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1962. A. Aarkrog, J. Lippert, and J. Petersen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). June 1963. 147p.

Results are summarized from the measurement of fallout radioactivity in Denmark in 1962. Strontium-90 was determined in samples of precipitation, cultivated soil, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables and fruit, total diet, and human bone. Furthermore Sr^{90} was determined in local samples of air, rain water, grass, sea water, sea plants, animal bone, and human milk. Estimates of the mean content of Sr^{90} and Cs^{137} in the human diet in Denmark from 1962 are given. In the autumn a survey of the I^{131} content of Danish milk was carried out. Results are also included from regular surveys of environmental samples from the Risø area. (C.H.)

5480 (RISÖ-64) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1962. A. Aarkrog, J. Lippert, and J. Petersen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1963. 30p.

Results are reported from measurements of fallout radioactivity in the Faroe Islands during 1962. Data are presented on the content of Sr^{90} in samples of precipitation, grass, milk, potatoes, drinking water, sea water, sheep, sea plants, fish, whales, and birds. Estimates are included on the mean content of Sr^{90} and Cs^{137} in the human diet and in the bone samples. (C.H.)

5481 (TID-19820) RAIN SCAVENGING OF PARTICULATE MATTER FROM THE ATMOSPHERE. Final Report. A. Nelson Dingle and Donald F. Gatz (Michigan. Univ., Ann Arbor. Coll. of Engineering). Sept. 1963. Contract AT(11-1)-739. 112p. (ORA-02921-4F)

Data relating to rain cleansing of the atmosphere have been gathered throughout six different rain-producing weather systems and analyzed with respect to the concentrations of radioactivity in successive samples. For some of the rains, analysis of the pollen content of sequential samples was also made. The variations of the respective contamination levels of rain samples within and between storms are examined in relation to several existing hypothetical relationships set forth in literature. Verification of the projected hypothesis fails in most cases, and appears in others to be fortuitous. It is concluded that more specific attention to the physical processes of scavenging during cloud- and rain-drop formation, and to the effects of accretion, coalescence, and evaporation in the fall of the raindrops will be fruitful. Three categories of identifiable contamination are noted: (1) old radioactive debris; (2) fresh radioactive debris; and (3) airborne pollens. These are observed to have differing source regions, and their study is expected to clarify details of the scavenging processes and of rainstorm dynamics. A model for rain cleansing by convective systems is proposed after consideration of the convective storm models of Newton (1950) and of Browning and Ludlam (1962) in relation to the observed variations of the various kinds of contamination. (auth)

5482 (UWFL-79) RADIOACTIVITY IN THE BIOTA AT ISLANDS OF THE CENTRAL PACIFIC, 1954-1958. Ralph F. Palumbo (Washington. Univ., Seattle. Lab. of Radiation Biology). Feb. 15, 1962. Contract AT(45-1)-1385. 65p.

Results are summarized from measurements of radioactivity in the biota at the Eniwetok Proving Grounds and islands adjacent to the test site during and after Operation Castle in 1954, Operation Redwing in 1956, and Operation Hardtack in 1958. Measurements were also made of radioactivity in tuna from the western Pacific and Indian Oceans during and after Operation Hardtack. Off-site collection areas included locations in the Marshall, Caroline, and Gilbert Islands. (C.H.)

5483 (JPRS-21975(Del.)(p.1-9)) THE RADIOACTIVITY LEVEL OF THE ATMOSPHERIC AIR OF MOSCOW FROM 1957 TO 1961. A. S. Zykova, E. (Ye.) L. Telushkina, G. P. Efremova (Yefremova), and V. P. Rublevskii (Rublevskiy). Translated from Gigiena i Sanit., 28: No. 9, 5-11(Sept. 1963).

Data on the dynamics of radioactive precipitations and on the radioactivity of the atmosphere air in Moscow during 1957 to 1961 are presented. The maximal concentrations of radioactive substances in the atmosphere were noted in March 1958 and amounted to 1.0×10^{-14} C/l. In 1957, 1047 mC long-life beta-active substances fell on a square kilometer of ground in the investigated district, in 1958—1114 mC, in 1959—998 mC, in 1960—45.88 mC, and in 1961—220 mC. Radiochemical analysis revealed the atmospheric precipitates to contain strontium-90, cesium-137, and cerium-144. (auth)

5484 THE MEASUREMENTS OF THE ARTIFICIAL ATMOSPHERIC RADIOACTIVITY. STATISTICAL ASPECTS AS TO ERRORS, COMPARABILITY AND REPRESENTATIVENESS. C. Levert. Arch. Meteorol., Geophys. Bioklimatol., 13: 408-22(1963).

Methods and types of instruments for measuring the specific artificial atmospheric radioactivity are discussed. To compare the simultaneous daily measurements made at different stations of a network, or the random and systematic errors that are characteristic for a particular measuring method or instrument, the meaning of simultaneous daily measurements and representativeness of a point measurement is explained and a method of calculation is developed, which is illustrated by a numerical example. (TCO)

5485 A NOMOGRAPH FOR THE INTERPRETATION OF ANOMALOUS LEAD ISOTOPE ABUNDANCES. R. M. Farquhar and R. D. Russell (Univ. of British Columbia, Vancouver). Geochim. Cosmochim. Acta, 27: 1143-8(Nov. 1963).

The construction of a simple nomograph for finding solutions for t_1 and t_2 in the formula, $R = (e^{\lambda' t_1} - e^{\lambda' t_2})/\alpha(e^{\lambda t_1} - e^{\lambda t_2})$, which is useful for interpreting anomalous lead isotope abundances, is described. The nomograph does not require interpolation. Formulas are given for the slope of the best line through the measured isotope ratios and its standard deviation. These assume equal errors in the Pb^{206}/Pb^{204} and Pb^{207}/Pb^{204} ratios. (auth)

5486 ARGON DETERMINATION IN POTASSIUM MINERALS. XII. NOBLE GAS DIFFUSION MEASUREMENTS IN STONE AND IRON METEORITES. H. Fechtig, W. Gentner, and P. Laemmerzahl (Max-Planck-Institut für Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 27: 1149-69(Nov. 1963). (In German)

The diffusion of noble gases (He, Ne, Ar) was measured on some stone meteorites of very different K–Ar ages and on one iron meteorite. Both artificially produced radioactive Ar^{37} and the natural radiogenic and cosmogenic stable Ar isotopes were used to investigate the argon diffusion; radiogenic He^4 and the cosmogenic He and Ne isotopes were also measured. With isothermal diffusion a decrease of D/a^2 (D = diffusion constant, a = grain radius) was observed and interpreted as successive degassing of the meteorite crystals of different sizes. The influence of this effect on the temperature dependence of D/a^2 can be eliminated. On the stone meteorites activation energies of about 45 kcal/mole were obtained for the diffusion of pile produced Ar^{37}, radioactive and stable spallation argon, and radiogenic Ar^{40}; for helium and neon the values obtained were about 35 to 40 kcal/mole. On the iron meteorite the activation energies for cosmogenic He, Ne, and Ar were about 60 kcal/mole. At room temperature D/a^2 is so small ($<10^{-23}$ sec^{-1} for argon, $<10^{-17}$ sec^{-1} for helium and neon) that no diffusion losses are possible after the fall of the meteorite. The temperatures occurring on meteorites in space outside the orbit of the earth do not suffice to explain differences in the radiogenic ages by diffusion losses. Additional heating-up, possibly caused by collisions, has to be taken into consideration. (auth)

5487 THE ISOTOPIC COMPOSITION OF LEAD IN EASTER ISLAND RHYOLITE. C. Patterson and B. Dufield (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta, 27: 1180-1(Nov. 1963).

A sample of Cerro Ourito obsidian, a rhyolite from the Mount Ourito flow on Easter Island, was analyzed for its lead isotope composition. The isotopic compositions of the leads were found to be identical to the compositions found in a dredge sample of K-feldspar, which was collected about 1000 miles apart from the rhyolite on the East Pacific rise. Data are tabulated. (P.C.H.)

5488 NATURAL RADIOACTIVITY AS CLIMATE FACTOR AND FISSION PRODUCT ACTIVITY FROM ATOMIC BOMB EXPERIMENTS IN ATMOSPHERIC AEROSOLS IN THE LOWER AIR IN AUTUMN 1961. A. Maas (Kernforschungsanlage Jülich, Ger.). Meteorol. Rundschau, 15: 45-7 (1962). (JUL-56-ST). (In German)

For two different kinds of atmosphere situations (for times of 4 days) before resumption of the Russian atomic bomb tests in September 1961, mean daily variations of the natural aerosol activity were calculated and compared with the daily variations of the aerosol activity after appearance of the fission products from the bomb tests after September 1, 1961 in the northwest region of Germany for two similar atmospheric situations. Results showed that the artificial radioactivity did not exhibit the same daily variations as the natural aerosol radioactivity and about 14 days after the resumption of the bomb tests, on the average, a proportionate increase in the natural activity of the aerosols was observed. The usefulness of monitoring the aerosol activity for control systems in reactor and nuclear research installations for recognition of artificial radioactive particles is discussed. (tr-auth)

5489 SOME REMARKS ON THE EVALUATION OF THE ABSOLUTE RADIOACTIVITY IN THE EVAPORATIONS OF PRECIPITATIONS AND FALLOUT. P. Petrovic (Hydrometeorological Inst., Prague). Meteorol. Zpravy, 16: 107-10(Aug. 31, 1963).

Problems concerning the calculation of the radioactivity in the evaporations of precipitations and atmospheric fallouts and the evaluation of errors by comparing the pulse count of samples with that of $Sr^{90} + Y^{90}$ and K^{40}, or the 100 day old fission-product mixture of U^{235} are discussed. A definition is given of absorption and self-absorption factors. Five calculation methods are presented for determining the absolute beta radioactivity. (OTS)

5490 THE DETERMINATION OF THE SPEED OF DEPOSITION OF RADIOACTIVE DUST AT ISPRA. P. Gaglione, E. Van Der Stricht, M. De Bortoli, and A. Malvicini (Euratom, Ispra, Italy). Minerva Nucl., 7: 349-53(Sept. 1963). (In Italian)

A method for measuring the deposition rate of atmospheric dust at ground level, by employing the fission products found in the air after nuclear explosions, is described. The method is based on a comparison between the radioactivity measured on a horizontal surface and the concentration in the air of the same radioisotope. The results of measurements made during a six-month period in 1962 are reported. For this period the mean deposition rate was 0.18 ± 0.08 cm/sec. From this it is possible to deduce the quantity of dry fallout and to assess its significance in relation to wet fallout. (auth)

5491 RADIOACTIVE FALLOUT. W. F. Libby. p.115-134 of "Proceedings of Nuclear Energy Conference." [Russellville, Arkansas, Arkansas Polytechnic College, 1963].

Physical aspects of the distribution in nature of radioactive fallout are discussed. The aggregate total radioactive fallout in the world is discussed and predictions of future fallout are made on the basis of what is known from figures to date. (P.C.H.)

Techniques and Equipment

Refer also to abstract 5689.

5492 NUCLEAR GEOPHYSICS. [Vol.] I. Proceedings of the Nuclear Geophysicists Conference, September 24-30, 1962, Krakow, Poland. J. A. Czubek, ed. Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

Various methods and problems in radiation prospecting and well logging are discussed. Of the 10 papers presented in this Volume, 7 were chosen for NSA, 3 having previously been abstracted. (R.E.U.)

For abstracts of individual papers see: 5493, 5494, 5495, 5496, 5497, 5498, and 5499.

5493 METHODS OF NUCLEAR GEOPHYSICS OF OIL AND GAS BORE-HOLE INVESTIGATIONS IN USSR. F. A. Alekseev (All-Union Scientific and Research Inst. of Nuclear Geophysics and Geochemistry, Moscow), I. L. Dvorkin, R. A. Rezvanov, D. M. Srebrodolskii, and S. L. Abramyan. p.41-72 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The isotope method is used in the investigation and control of the technical condition of the borehole. Radioactive isotopes, usually Fe^{59} and Zn^{65}, are used to determine the location of the flow and the circulation zone outside the tubes, the places of crack in the pipe lines, the height of the position of the cement, and even its thickness in the space outside the casing. Isotopes are also used to increase the accuracy of the depth determination for the perforation of the casing and for some other purposes. (auth)

5494 SOME PROBLEMS IN THE THEORY OF NEUTRON LOGGING. C. W. Tittle (Southern Methodist Univ., Dallas). p.73-95 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

An extension of the one-energy-group diffusion theory of epithermal neutron logging in borehole geometry is presented. A systematic scheme of calculation, employing the digital computer Univac-1103, was undertaken. The parameters of the outer medium covered a wide range of values, and borehole radii of 5, 6, and 8 cm were employed. Representative results are given in the form of curves. The entire numerical results obtained were summarized by computing two empirical parameters, L and D, which describe approximately the variation of neutron flux when the real parameters are changed. This method of presentation affords a convenient way of visualizing these effects. (auth)

5495 NEUTRON-NEUTRON PULSE WELL-LOGGING. F. A. Alekseev, D. F. Bespalov, B. G. Erozolimskii, D. M. Srebrodolskii, N. V. Popov, Yu. S. Shimelevich, and A. S. Shkolnikov (State Scientific and Research Institute of Nuclear Geophysics and Geochemistry, Moscow). p.97-126 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The method is applied to cased holes for several oil and gas deposits. The problems of theory, the methods, and the results are presented. The profile of oil- and gas-bearing layers was selected with good results, and the gas–liquid and water–oil contacts were well-determined with small mineralization of internal waters. (R.E.U.)

5496 ON THE CALIBRATION AND INTERPRETATION OF NEUTRON-GAMMA LOGS IN THE GERMAN DEMOCRATIC REPUBLIC. K. Lehnert (State Oil and Gas Plant, Gommern, Ger.). p.147-64 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic

Information Center of the Government Commission for Atomic Energy, [1963].

General consideration is given to the neutron-gamma counting rate and the calibration procedure chosen. Some methods that proved successful in lithology evaluation and estimation of effective porosity are described and illustrated by examples. The development of a general interpretation technique applicable to all types and equivalents of the Zechstein carbonates is delineated. (auth)

5497 THE APPLICATION OF METHODS OF NUCLEAR GEOPHYSICS FOR THE DETERMINATION OF CHEMICAL COMPOSITION OF ORES IN THEIR NATURAL DEPOSITS. Yu. P. Bulashevich and I. N. Senko-Bulatnyi (Inst. of Geophysics, Ural Department Academy of Sciences, Sverdlovsk, USSR). p.201-35 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The results of investigations on the application of spectrometric variants of selective and activation well logging and the experimental application of this method for chemical composition of natural ore deposits are discussed. A 30-channel spectrometric probe on a standard three-core cable is described. (R.E.U.)

5498 APPLICATION OF Po + B AND Ac + Be NEUTRON SOURCES IN PROSPECTING GEOPHYSICS. R. L. Kaipov, E. B. Blankov, D. M. Ziv, D. L. Leipunskaya, V. P. Spiridonov, V. V. Fedorov, G. M. Fradkin, B. I. Shestakov, and Y. C. Shimielevich (All-Union Scientific and Research Inst. of Nuclear Geophysics and Geochemistry, Mowcow). p.277-88 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The advantages of actinium–beryllium neutron sources and a comparison to polonium–boron and -beryllium sources for neutron-gamma well logging are discussed. (R.E.U.)

5499 NATURAL GAMMA-RAY LOGGING FOR THE DENSITY LOGGING PURPOSES. J. A. Czubek (Inst. of Nuclear Research, Krakow). p.289-303 of "Nuclear Geophysics. [Vol.] I." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

New methods for the evaluation of rock densities from gamma-ray logs are discussed. This interpretation is possible only for the special cases of radioactive layers. This new method may be applied as an auxiliary one to the gamma-gamma method. (auth)

5500 NUCLEAR GEOPHYSICS. [Vol.] II. Proceedings of the Nuclear Geophysicists Conference, September 24-30, 1963, Krakow, Poland. J. A. Czubek, ed. Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

Various methods and problems in radiation prospecting and well logging are discussed. Of the 10 papers presented in this Volume, 9 were chosen for NSA, one having previously been abstracted. (R.E.U.)

For abstracts of individual papers see: 5501, 5502, 5503, 5504, 5505, 5506, 5507, 5508, and 5509.

5501 ON THE THEORY OF NEUTRON LOGGING. S. A. Denisik (Ghubkin Institute of Oil-Chemistry and Gas Industry, Moscow), I. G. Dyad'kin, S. A. Kantor, D. A. Korshevnikov, B. E. Lukhminskii, A. L. Polyachenko, R. A. Rezvanov, and B. M. Rudyk. p.315-38 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The problems of stationary and nonstationary slowing down of neutrons in a medium as applied to neutron methods of borehole investigation are discussed, and the results of work done in the USSR in recent years are presented. The space distribution of neutrons in a medium crossed by a borehole and also the distribution of neutrons from an anisotropic source were obtained by the method of statistical tests. (auth)

5502 FORMATION DENSITY LOGGING/GAMMA-GAMMA/PRINCIPLES AND PRACTICE. J. Tittman and J. S. Wahl (Schlumberger Well Surveying Corp., Ridgefield, Conn.). p.339-92 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

The basic features of gamma interaction with bulk media are reviewed, with special orientation towards those applied in the density logging of earth formations. Comparisons are made among several common methods of solving the Boltzmann equation in media of interest. The notions of energy degradation, diffusion, and the establishment of an equilibrium spectrum are applied to the description of the density measurement. Special attention is paid to the use of the Compton effect in avoiding chemical influences, especially those resulting from variations in rock matrix, on the density measurement. The lack of perfect proportionality between electron density and bulk density is discussed. A direct comparison is made between results of a simple diffusion theory and experiments with a practical application. The problems of relating the formation density measurement to other variables of geologic or petroleum engineering interest, of accurate porosity values, gas and liquid saturations, and the nature of the rock matrix are described and illustrations presented from field practice. (auth)

5503 CORRELATIONS OF COAL LAYERS BY MEANS OF THE GAMMA-RAY LOGS. S. Plewa (Petroleum Inst., Krakow). p.393-404 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish)

The layers of hard and brown coal are detected through a complex of well logs. The log of natural intensity of gamma radiation is part of that complex. It is also used for the correlation of coal seams. This correlation is based on a radiometric benchmark or on the radiometric characteristics of some layers of hard coal. The coal layer identifications are indirectly possible through this geophysical correlation. (auth)

5504 DETERMINATION AND CORRELATION OF GLAUCONITE SANDSTONES WITH PHOSPHORITES BY MEANS OF THE NATURAL GAMMA WELL-LOGGING. S. Plewa and K. Mrozek (Petroleum Inst., Krakow). p.405-17 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish)

Glauconite sandstones with phosphorites are contaminated by radioactive elements. Their concentration increases the intensity of natural gamma radiation. This was utilized in prospecting for phosphorites that are characterized by maximal anomalies on the gamma diagram. The correla-

tion of gamma curves serves to determine the bed. Investigations on the quantitative interpretation of the discussed anomalies are being carried out. (auth)

5505 SOIL MOISTURE MEASUREMENT BY NEUTRON METHOD. A. Zuber (Inst. of Nuclear Technology, Academy of Mining and Metallurgy, Krakow). p.419-47 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

The neutron method of moisture measurement, using a G-M counter surrounded by cadmium as detector, is discussed. The results of experiments on optimal choice of construction parameters for surface measurements and in the boreholes are presented. The advantages and disadvantages of this method are discussed on the basis of the comparative experiments made by the proportional counters as detectors. The range of the method and the influence of the ground surface on the measurement in the borehole is given. The state of investigations on the influence of the density of soil on the measurement of its moisture and on the influence of contamination with some elements that absorb the neutrons are presented. (auth)

5506 DEVICES FOR DETERMINATION OF BULK-DENSITY OF SOILS USING THE GAMMA-RAY SOURCES. B. Dziunikowski and J. Niewodniczanski (Inst. of Nuclear Technology, Academy of Mining and Metallurgy, Krakow). p.449-58 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

Devices for the determination of bulk-density of soils are described. These devices, based on the principle of measurement of gamma-ray scattering and absorption, are designed for investigation of soils in different technical conditions. The probe is presented which measures the bulk-density of loose soils in the bottom of any boreholes, or other exploited areas, then two probes with the diameters of 20 and 38 mm for shallow research boreholes logging, and the probe for surface measurements. A device intended for investigation of the surface layer of soils up to 40 cm is described; it is the absorption probe. The sensitivity of devices is discussed. (auth)

5507 NEUTRON-ACTIVATION ANALYSIS OF BAUXITES AND COALS WITH PORTABLE NEUTRON-SOURCES. J. Tatár and M. Béress (Roland Eotvos State Geophysical Inst., Budapest). p.459-81 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

The quantitative classification of the bauxites is based on the ratio of Al_2O_3 and SiO_2 prescriptions. The neutron-activation method gives the possibility of determining the aluminum and silicon with great accuracy. The Al^{27} transforms by slow neutrons, but the Si^{28} by fast neutrons to Al^{28}. The isotope abundance and the neutron-capture cross section of the isotopes of aluminum and silicon make it possible to bring about this nuclear reaction in boreholes with sufficient intensity. The solution of this problem was first achieved within laboratory conditions. The resolution of the two unknown equations resulting from a separate slow and a separate fast neutron irradiation gives the value of silicon and aluminum concentration. A sample of 30 g was irradiated for 4.6 minutes. The concentration values of the bauxite measured by the portable activation equipment deviated from the values of the classical methods as follows: Al_2O_3, ±0.8%; SiO_2, ±0.4%. These results make the introduction of this method at field surveys possible. The technological quantitative characteristics of coal samples (caloricity, heat values, etc.) show a good relation with the ash percentage. The quantitative variation of Fe_2O_3, CaO, and MgO is very small in the ash of the Hungarian coals in comparison with the variation of SiO_2 and Al_2O_3. The ash and also the other technological characteristics are in good relation with the variation of the quantity of silicon and aluminum. The black coal samples were irradiated in the same way for 4.6 minutes. The average deviation of the ash percentage from the ash content obtained by activation analysis and by classical methods was only ±0.2%. (auth)

5508 NEUTRON GENERATORS FOR WELL STUDIES. D. F. Bespalov and S. I. Savosin (All-Union Scientific Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). p.483-97 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

A borehole neutron-pulse generator is described that allows neutron-activation analysis of increased resolution. The working characteristics and results of application in industry are discussed. A continuous-type generator is also described. (R.E.U.)

5509 PULSED NEUTRON EXPERIMENTS IN A BOREHOLE MODEL. William R. Mills, Jr., George N. Salaita, Tom J. Gray, and Richard L. Caldwell (Socony Mobil Oil Co., Inc., Dallas). p.499-541 of "Nuclear Geophysics. [Vol.] II." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

Pulsed-neutron experiments were performed in a borehole model to determine the effects of tool position, borehole fluid, and source-detector spacing on pulsed-neutron-thermal-neutron logging. Neutron time distributions were measured with various combinations of the above parameters and a sand model of 32.5 percent porosity filled with fresh water or salt water with 230 gms/liter NaCl. Approximate neutron lifetimes determined from the distributions indicate the degree of validity of the assumption that borehole effects are largely ignored in this logging method. (auth)

5510 NUCLEAR GEOPHYSICS. [Vol.] III. Proceedings of the Nuclear Geophysicists Conference, September 24-30, 1962, Krakow, Poland. J. A. Czubek, ed. Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

Various methods and problems in radiation prospecting and well logging are discussed. Of the 11 papers presented in this volume, 10 were chosen for NSA, one having previously been abstracted. (R.E.U.)

For abstracts of individual papers see: 5511, 5512, 5513, 5514, 5515, 5516, 5517, 5518, 5519, and 5520.

5511 METHODS OF RAPID DETERMINATION OF CONCENTRATION OF ELEMENTS IN ORE SAMPLES BASED ON X-RAY FLUORESCENCE ANALYSIS AND ABSORPTION METHOD. B. Dziunikowski and T. Florkowski (Academy of Mining and Metallurgy, Krakow). p.543-60 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish)

The modern methods of ore exploitation often require a rapid analysis of mineral samples for investigated elements. Radiometric methods utilizing the phenomenon of

selective absorption of soft gamma radiation or exciting x-ray fluorescence can be such rapid method of analysis. The absorption analysis was applied to determine the lead concentration in a sample using a bremsstrahlung source $Sr^{90} + Y^{90}$, with uranium targets. (auth)

5512 APPLICATION OF GAMMA-RAY SPECTROMETRY IN OIL AND GAS PROSPECTION IN BULGARIA. D. S. Iosifov (Scientific-Research Geological Inst., Sofia). p.561-77 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

5513 THE APPLICATION OF NUCLEAR GEOPHYSICS METHODS IN THE CONTROL OF STRUCTURE OF UNDERGROUND GAS RESERVOIRS IN USSR. A. I. Kholin, Yu. V. Galuzo, and M. M. Sevastianov (Ghubkin Inst. of Petrochemical and Gas Industry, Moscow). p.579-98 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The physical principles of neutron methods for control of gas deposit occurrence, gas pressuring, and escape from a gas-bearing layers are presented. The circuit diagrams and the construction of a small probe for borehole radiometry are described and also the construction of the surface accessories used in geophysical investigation of gas boreholes under pressure. Radiometric investigations on the structure of underground gas reservoirs are analyzed. Examples of several gas deposits show the high efficiency of neutron methods in the control of gas occurrence inside the layer, especially the method used and the results of the quantitative interpretation of gas-bearing layers in different parts of the bed. The regularity of water flooding through the air and gas in the thickness of the layer and the area of flooding are considered. The variations as the function of volume of air or gas-injection and the position of observation wells in relation to the pressuring well were analyzed. (auth)

5514 RAPID ACTIVATION ANALYSIS OF SILICEOUS ROCKS. V. V. Glasson, V. I. Drinkin, D. I. Leipunskaya, and N. D. Putyatina (All-Union Scientific and Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). p.599-612 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

Neutron activation analysis of siliceous rocks is made for Al, Si, Mn, Na, and K elements or their short-lived radioactive isotopes without chemical destruction of the samples. Al and Si contents in the samples were determined simultaneously by two irradiations with neutrons of different energies according to the reactions $Al^{27}(n,\gamma)Al^{28}$ and $Si^{28}(n,p)Al^{28}$. Generally, beta activity is registered. The sensitivity of the analysis for Al and Si with the use of a Po + Be source of 10^7 n/sec intensity is 3% for Al and 5 to 7% for Si. The accuracy of the analysis is 3% of the measured content. One analysis by means of the self-recorder circuit takes 30 minutes. Mn contents are determined from the beta radiation of the radioactive isotope $Mn^{56}(T_{1/2} = 2.56$ hrs) or from gamma radiation with a scintillation spectrometer in order to be free from the interference of chloride radiation. (auth)

5515 THE ANOMALIES OF THE GAMMA-FIELD OVER SOME OIL AND GAS FIELDS IN ROUMANIA. E. Ghon and E. Bratashanu (Ministry of Petrochemical Industry, Geological Lab., Bucharest). p.613-35 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

A description of the history of the investigations carried out in Roumania in 1956-1961 in order to test the possibilities of application of radiometric methods in prospecting for deposits of hydrocarbons is given. Part of the radiometric anomalies that are considered characteristic according to the interpretation were tested by drilling. Experimental radiometric prospecting work carried out on the surface of nine well-known oil and gas fields is described further. This work accomplished using portable radiometers allows the anomalous value of the gamma field over the bed to measured. The comparative investigation of the results shows a direct relation of the registered intensity of gamma radiation on the surface and the oil content in the bed. The characteristic radiometric anomalies for gas fields were not found. Several side factors noticed during the investigation were treated according to the interpretation in each case, either as the influence of surface factors or as the influence of the structure of the deposit. (auth)

5516 RAPID ANALYSIS OF ROCK AND ORE SAMPLES BY MEANS OF BACK-SCATTERING OF BETA PARTICLES. E. E. Sozanskaya, M. M. Sokolov, E. I. Dolgirev, and V. P. Nikolaev (All-Union Scientific Research Inst. of Prospecting Geophysics, Leningrad). p.637-55 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The effective atomic numbers of rocks and ores were determined using a Sr^{90} beta source. The analysis was performed on samples of granites, shales, limestones, and jaspers, polymetallic ore samples, mercury, antimony, and uranium ores. (R.E.U.)

5517 SOME PROBLEMS OF GAMMA-RAY SPECTROMETRY FOR QUANTITATIVE DETERMINATION OF ELEMENTS "IN SITU." M. M. Sokolov and A. A. Fedorov (All-Union Scientific Research Inst. of Prospecting Geophysics, Leningrad). p.657-87 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

Methods are discussed for determination of elements in ores and parameters of rocks crossed with boreholes. A scintillation spectrometer with several channels is used. (R.E.U.)

5518 AN INCREASE OF ACCURACY OF THE RESOURCE ESTIMATION OF URANIUM ORES BY MEANS OF PROPER DETERMINATION AND TESTING OF THE CALIBRATION FACTOR. S. Barabas (Industrial Establishments R-1, Kowary, Poland). p.715-29 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The determination and dependence of the calibration factor for accurate determination of uranium ore content in a bed are discussed. The calibration factor is calculated in an artificial borehole. (R.E.U.)

5519 THE RADIOMETRIC EQUIPMENT FOR THE INVESTIGATION OF BOREHOLES. S. L. Abramyan (Trust Azneftegeofizika, Baku). p.731-60 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

One- and two-channel devices developed in the USSR for

well logging are discussed. The probes are the Neutron-Gamma-Gamma Logging-60 and the TRK type. (R.E.U.)

5520 NEW RADIOMETRIC METHODS APPLIED IN CONTROL OF FLOODING IN OIL DEPOSITS IN TATARIA. E. B. Blankov, T. N. Blankova, M. B. Kadisov, and F. A. Kurilenko (Trust Tatneftegeofizika, Bughulma, Tatarian SSR). p.761-79 of "Nuclear Geophysics. [Vol.] III." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The application of borehole pulse neutron generators is discussed. The method is based on the analysis of the deviation from the exponential decay law of Na^{24} in the case of water movement. (R.E.U.)

5521 NUCLEAR GEOPHYSICS. [Vol.] IV. Proceedings of the Nuclear Geophysicists Conference, September 24-30, 1962, Kracow, Poland. J. A. Czubek, ed. Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

Various methods and problems in radiation prospecting and well logging are discussed. Of the 14 papers included, all were abstracted separately for NSA. (R.E.U.)

For abstracts of individual papers see: 5522, 5523, 5524, 5525, 5526, 5527, 5528, 5529, 5530, 5531, 5532, 5533, 5534, and 5535.

5522 APPLICATION OF GAMMA-RAY SPECTROMETRY FROM THE CAPTURE AND EXCITED ACTIVITY IN THE INVESTIGATION OF CHEMICAL COMPOSITION OF ROCKS. A. I. Kholin, K. I. Yakubson, and G. A. Nedostup (Moscow Inst. of Petrochemical and Gas Industry). p.781-811 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The measured gamma spectra of rock which has undergone capture of thermal neutrons is considered as a superposition of gamma spectra from separately excited nuclei. A special model was used to estimate the gamma spectra characteristics of Al, Na, Mn, Cu, Fe, Ni, S, Ca, and Si and their compounds that are basic rock-building elements. Application is made to finding ore horizons in a borehole in copper–nickel ores and bauxites. (R.E.U.)

5523 THE INFLUENCE OF THE BORE-HOLE DIAMETER ON THE SHAPE OF CALIBRATION CURVE OF THE NEUTRON PROBE FOR SOIL MOISTURE MEASUREMENTS. J. Krzuk (Academy of Mining and Metallurgy, Krakow). p.813-33 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish)

The relation between the counting rate and the moisture content of the soil is investigated theoretically and experimentally. Slowing down of neutrons in the rock surrounding the borehole is treated as a diffusion approximation (age theory), but spreading out of neutrons in an empty borehole is considered as kinematic. (R.E.U.)

5524 THE MODEL STUDY OF THE NEUTRON METHODS FOR THE SOIL WATER DETERMINATION. K. Przewłocki (Inst. of Nuclear Technology, Academy of Mining and Metallurgy, Krakow). p.835-52 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

The results of model measurements of the field of slow resonance neutrons along the axis of the borehole are presented. The measurements were taken in two different porosities, several different pipe diameters, and for a dry borehole and borehole filled with water. Detailed measurements for short probes in 1 to 10 cm source-detector range were taken with indium foils. The results obtained were compared with well-logging theory for measuring soil moisture. (auth)

5525 WELL-LOGGING IN GEOLOGICAL PROSPECTING FOR ROCK SALT AND POTASSIUM SALT DEPOSITS IN BY-CARPATHIAN REGION OF EASTERN CARPATHIAN MOUNTAINS. L. Cojocariu (Ministry of Mining and Electric Energy, Trust of Prospecting Works, Bucharest), H. Siell, and V. Marghitu. p.853-69 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

Methods are described that are used in well-log prospecting for rock salt and potassium salt deposits. Both radiation measurements and electric logging are discussed. (R.E.U.)

5526 CONTROL OF WATER DAM BASEMENTS AND EXPLORATION OF GEOLOGICAL DISLOCATIONS BY MEANS OF RADIOMETRIC SURVEY. R. Jirkovský (Academy of Mining and Metallurgy, Ostrava, Czechoslovakia). p.871-83 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

Natural-radioactivity measurements were made in order to identify geological dislocations and contacts of rocks on territories covered with alluvials, sands, gravels, meadows, and bushes for the purpose of geological cartography. (R.E.U.)

5527 APPLICATION OF RADIOACTIVE ISOTOPES IN THE CONTROL OF HYDRAULIC FRACTURING. J. Szymański (Petroleum Inst., Krakow). p.885-96 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish)

Hydraulic fracturing of oil-bearing layers was determined using radioactive sand and gamma well logging in a fractured borehole. (R.E.U.)

5528 MATHEMATICAL LOGIC IN THE ANALYSIS OF INFORMATION CORRESPONDING TO GEOPHYSICAL PROPERTIES OF GEOLOGICAL FORMATIONS. I. Lari and D. Stefanescu (Ministry of Mining and Electric Energy, Bucharest). p.897-914 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

A mathematical model corresponding to operation research in the petroleum industry is used to evaluate the efficiency of radiometric methods. The model is defined as a computing algorithm, and the possibility of programming for computer use is discussed. (R.E.U.)

5529 GAMMA-RAY SURVEYING ON EARTH AND ON THE MOON. H. Faul, A. Griscom, and R. M. Moxham (Geological Survey, Washington, D. C.). p.915-21 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish, English, and Russian)

The purpose and some expected results of terrestrial and lunar gamma surveys are discussed. (R.E.U.)

5530 DETERMINATION OF THE ORIGIN OF MINE GASES BY MEANS OF THE ISOTOPIC CONSTITUTION OF THE ELEMENTS CARBON AND NITROGEN. J. Muehlenpfordt (Inst. of Separation of Materials by Physical Methods, German Academy of Sciences, Berlin, Leipzig), I. Maass, O. Oelsner, and J. Pilot. p.923-42 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963].

The variations in stable isotopic constitution depending on the origin of the elements are used to solve technical problems of mining analyses of carbon from hydrocarbons and nitrogen from mine gases in an iron ore mine. From these determinations, the origin of the mine gases is discussed. (R.E.U.)

5531 DETERMINATION OF THE PERMEABLE ZONES IN THE WATER INJECTION WELLS BY MEANS OF RADIOACTIVE TRACERS. J. Szymański (Petroleum Inst., Krakow). p.943-58 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Polish)

The structure of the oil-bearing layer into which water is forced during the flooding often makes the proper pumping in impossible. Meeting more porous layers or fractures, water goes through them without fulfilling its purpose of forcing out the oil. In order to find the places of greatest absorbing capacity in such a borehole and to find out whether the water goes into the bed through the proper layer, water contaminated with a radioactive isotope is forced into the borehole. Then by taking a series of gamma measurements in this borehole after forcing in fresh water, it is possible to find out on gamma logs the place of the greatest water absorbing capacity. Water contaminated with zinc and iodine radioactive isotopes was used for that purpose. In each case it was possible to determine the zones of the greatest water-absorbing capacity of the investigated bed. (auth)

5532 AIM TO INCREASE OF APPLICATION OF OPERATIONS WITH THE RADIOACTIVE INDICATORS IN OIL INDUSTRY IN ROUMANIA. Gh. Peteu (Ministry of Oil and Chemical Industry, Bucharest). p.959-77 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

5533 CHANGES OF THE RADIUM CONTENT IN BORE-HOLE WATERS ACCORDING TO THEIR GENETIC KIND. E. Bratashanu and E. Chon (Ministry of Petrochemical Industry, Bucharest). p.979-91 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The results of determination of radium content based on the analysis of 270 samples of internal water are presented. The investigations were carried out by emanometric laboratory methods. According to the results obtained the calcium chloride type of water, considered as typical for closed hydrological basins, has a higher content of Ra. Taking the value 3×10^{-11} g Ra/l as the limit of deviations, conformity with exactly 87% of chemical analysis was obtained. The dependence of radium content in water on lithological and stratigraphical conditions, or depth at which samples were taken, was not observed. The obtained results show that in closed water reservoirs there is a general tendency to substitute the light alkaline terrigenous elements by heavier elements. (auth)

5534 APPLICATION OF OPEN ISOTOPE SOURCES IN THE INVESTIGATION OF OIL BORE HOLES ON HUNGARIAN OIL FIELDS. I. Dallos (Government Trust of Oil and Gas Industry, Budapest). p.993-1011 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

Tracer techniques for determining flow characteristics, rock fractures, and other properties applicable to oil wells are discussed. The radioactive sources are introduced in a water–NaI solution and also in the form of irradiated sands. (R.E.U.)

5535 THE APPLICATION AND THE TRENDS OF THE DEVELOPMENT OF RADIOMETRIC WELL-LOGGING IN THE OIL INDUSTRY IN ROUMANIA. V. Negoicy (Ministry of Oil and Chemistry, Ploesti, Rumania). p.1013-38 of "Nuclear Geophysics. [Vol.] IV." Warsaw, Scientific, Technical, and Economic Information Center of the Government Commission for Atomic Energy, [1963]. (In Russian)

The application of radiometric methods in boreholes drilled before electric methods of investigating oil boreholes were introduced is discussed. The results obtained by radiometric well logging in boreholes drilled through salt domes where mineralization of the drilling liquid limits the application of electric well logging are explained. The methods and results of applying gamma-gamma and neutron-neutron methods and the activation and spectral well-logging methods and the efficiency of these methods in relation to the problems solved are given. The problem of calibration of borehole probes is discussed. The importance of radiometric well logging in the Roumanian oil industry is stressed, and the main improvements of radioactive methods in investigating oil boreholes, which lead to a quantitative interpretation of physical parameters of hydrocarbon collectors, are pointed out. (auth)

5536 PROMYSLOVAYA GEOFIZIKA. (Industrial Geophysics). V. N. Dakhnov. Moscow, Gostoptekhizdat, 1963. 276p.

Methods of electrometric and radiometric well logging and their interpretation are considered. The radiometric investigations of the Karabi-Yaily limestones and the Mesozoic deposits of the Tersk-Kumsk plains are reported. Neutron diffusion in rock strata, age estimation, determination of pH of petroleum, application of potential probes, polarization methods, and the neutron-gamma method are discussed. (C.E.S.)

5537 IMPROVEMENTS IN OR RELATING TO A METHOD OF AND APPARATUS FOR LOGGING A BORE-HOLE. Gary Francis Roach and Eric Henry Ward (to British Petroleum Co. Ltd.). British Patent 938,488. Oct. 2, 1963. Filed July 14, 1961.

A method and apparatus are described for logging a borehole to detect in the formations traversed the presence or absence of chlorine at any particular level and to determine the relative abundance of the chlorine. A known brine-free formation and a formation known to have a high brine concentration are irradiated with neutrons from a source situated in the borehole. The occurrence and energy of γ rays emitted promptly by the nuclei of each of the formations are detected, and the count rates of the rays as functions of their energy are measured. An energy range within which the difference between the count rate obtained from the brine-free formation and the count rate obtained from the brine-containing formation is maximal and an energy minimum below which substantially all high count rate low energy

background radiation occurs are selected. The formations traversed by the borehole are then irradiated with neutrons from the same source moving through the borehole. The count rates of (a) the emitted γ rays having energies within the selected energy range and (b) the rays having energies greater than the selected energy minimum are measured. Each of the measurements is recorded as a function of distance along the borehole in such a manner that the two records are substantially superimposed when the count rates relate to radiation from a brine-free formation. The presence of chlorine is indicated by a divergence in the record relating to radiation having energies above the selected minimum. (A.G.W.)

5538 SUBSURFACE EXPLORATION. Karl C. ten Brink and Richard H. Widmyer (to Texaco Inc.). U. S. Patent 3,100,258. Aug. 6, 1963. Filed July 21, 1958.

An improvement to the method of measuring the permeability of earth formations traversed by a well or borehole is proposed. The improvement consists of incorporating into a hydrocarbon-oil stream to be introduced into a predetermined zone of the borehole a radioactive metallo-organic compound soluble in the hydrocarbon oil, substantially insoluble in water, nonpolar, and which does not seek an oil-water interface. The compound can be any of several compounds of As, Bi, Pb, Sb, or Hg. Such a compound can be easily flushed from the wall of a borehole by nonradioactive oil so that a subsequent survey may be made without encountering a high radiation background or waiting for decay of radioactivity. (A.G.W.)

5539 RADIOACTIVE WELL LOGGING. Joseph C. Allen and Hugh E. Hall, Jr. (to Texaco Inc.). U. S. Patent 3,100,259. Aug. 6, 1963. Filed May 7, 1959.

The proposed method of logging a high-pressure well includes lowering into a borehole a string of tubing extending from the mouth of the hole to the lowest point of interest and passing a logging unit through the tubing. A suitable plug is attached to the lower end of the tubing, and a pressure-tight seal is provided between the tubing and the casing head. The tubing may be filled with a liquid in order to prevent collapse in cases of extreme pressure. The device is particularly suitable for use in gas injectivity profile logging. (A.G.W.)

5540 GEOPHYSICAL PROSPECTING. Fontaine C. Armistead (to Texaco Development Corp.). U. S. Patent 3,102,956. Sept. 3, 1963. Filed Nov. 14, 1955.

In the suggested method of geophysical prospecting of an earth formation traversed by a fluid-containing borehole, the instrument used contains a pulsed neutron source and a detector of radiation returning from the formation. The procedure used consists of irradiating the formation with a timed burst of neutrons, discontinuing the irradiation, maintaining the detector inoperative during irradiation and for a short period thereafter, then activating the detector during a predetermined period of time. This sequence is continuously repeated as the instrument moves past the formation being investigated. The timing is so arranged that the detector is inoperative during the period when radiation emitted from the borehole contents is of maximum intensity and operative when radiation emitted from the formation is of maximum intensity. If desired, a substance having a measurably different neutron lifetime characteristic from that of average earth formations can be introduced and maintained between the sensitive volume of the detector and the formation. This substance can be incorporated in the borehole contents or can be provided as part of the logging instrument. In this manner, the effects of the contents of the borehole on the log are at least substantially minimized. (A.G.W.)

5541 RADIOACTIVITY SOURCE-AND-DETECTOR PROBE. Philip Shevick (to Nuclear-Chicago Corp.). U. S. Patent 3,103,588. Sept. 10, 1963. Filed June 11, 1958.

The probe described is specifically designed for measurement of moisture content of soil. It consists essentially of an elongated cylindrical housing permeable to neutrons in all directions, an elongated cylindrical BF_3 neutron counter, and a Ra–Be neutron source. The neutron counter has a sensitive length between 5 and 7 inches and is placed eccentrically within the housing to form a substantially crescent-shaped annulus between the counter and the housing. A Pb γ-ray shield substantially fills the crescent-shaped annulus. The neutron source is placed in the thickest portion of the shield substantially at the longitudinal center of the sensitive length of the counter. The probe is designed for use in a pipe or tube with internal diameter as small as $1\frac{1}{2}$ in. It is intended to be capable of simple industrial manufacture and to give accurate and reliable measurements by inexperienced personnel. (A.G.W.)

5542 COMPACT NEUTRON SOURCE. Alfred J. Gale and Richard J. Connor (to High Voltage Engineering Corp.). U. S. Patent 3,104,322. Sept. 17, 1963. Filed Feb. 10, 1958.

The neutron source described is adapted for use in regions having limited volume and to which only a limited amount of power can be delivered. The housing for the device is divided into two compartments. One compartment contains an ion source consisting of a solid metallic member having a sharp point and impregnated with at least one isotope of hydrogen. It may be made of any metal that absorbs hydrogen such as Ti, Pd, or Ni. The ions produced are accelerated toward a target suitable for production of neutrons. The second compartment contains an electrostatic belt-type generator adapted to maintain a negative voltage at the target with respect to the ion source. (A.G.W.)

5543 GEOPHYSICAL PROSPECTING DEVICE FOR IDENTIFYING RADIOACTIVE ELEMENTS. Jean Guitton and Claude Lallemant (to Commissariat a l'Energie Atomique). U. S. Patent 3,105,149. Sept. 24, 1963. Priority date Apr. 10, 1959, France.

A device is described for detecting and identifying at least two γ-emissive elements each of which has a γ-ray continuous spectrum including at least one peak. The device includes a scintillation γ detector, a pulse height analyzer with several output channels adjusted to deliver signals corresponding to selected γ energy bands, and recording apparatus connected with the output channels. One of the chief characteristics of the device lies in the choice of wide energy bands for defining the identification channels. The result is two curves traced simultaneously, which give, as a function of time, the variations of a signal depending on total radioactivity and therefore permitting detection, and the variations of a signal identifying the preponderant γ-emitting element. The device is especially suitable for aerial prospecting but may also be used for land prospecting. (A.G.W.)

HEALTH AND SAFETY

Refer also to abstract 6518.

5544 (EUR-112.e,f(Vol.1)) ÉTUDE DU TRANSPORT VERS LES ÉTATS-UNIS DES COMBUSTIBLES IRRADIÉS DANS LES RÉACTEURS DE PUISSANCE EUROPÉENS. VOL. 1. (Study of Irradiated Fuels Shipment from the European Power Reactors to the United States). Nov. 1962. (Lebon et Cie., Paris; Societe Generale d'Exploitations Industrielles, Paris; and Stanray Corp., Chicago). Work Performed under United States–Euratom Joint Research and Development Program. Contract 043-61-2 RDF. 35p. (EURAEC-374(Vol.1))

Transportation from Europe to the United States of fuels irradiated in the SENN and SENA reactors is considered. The problems resulting from the transports considered were evaluated and examined from a general viewpoint and in the light of concrete studies. (M.C.G.)

5545 (EUR-112.e,f(Vol.3)) ÉTUDE DU TRANSPORT VERS LES ÉTATS-UNIS DES COMBUSTIBLES IRRADIÉS DANS LES RÉACTEURS DE PUISSANCE EUROPÉENS. VOL. 3. (Study of Irradiated Fuels Shipment from the European Power Reactors to the United States). (Lebon et Cie., Paris; Société Générale d'Exploitations Industrielles, Paris; and Stanray Corp., Chicago). 1962. Work Performed under United States–Euratom Joint Research and and Development Program. Contract 043-61.2 RDF. 507p. (EURAEC-374(Vol.3))

The European part of the shipment of irradiated fuels from the SENN and SENA reactors to the United States is considered. Laws and regulations concerning transport in Europe are listed. Safety precautions are described. The methods employed are examined. The assurances, necessary approbations, formalities of accomplishment, measures to be taken in case of accident, costs, and applications to the specific reactors are discussed. Transport on the sea is also considered. The general program of costs for transport is outlined. (M.C.G.)

5546 (LAMS-2962) RADIATION HAZARD RESULTING FROM TRITIUM DIFFUSION IN GLOVE BOX OPERATIONS. George N. Krebs, Jr. (Los Alamos Scientific Lab., N. Mex.). Aug. 6, 1963. Contract W-7405-eng-36. 13p.

Tritium exposure to personnel handling tritium compounds in glove boxes can be significantly reduced by the wearing of surgeon's gloves while working in the dry-box gloves. To investigate this reduction quantitatively and to determine criteria for the frequency of glove change, mathematical analyses of the diffusion of HTO through dry-box rubber gloves with and without surgeon's gloves was made. The relative amounts of HTO absorbed by the worker as a function of time in the two cases was then compared. For tritium concentrations of $1C/m^3$ in the glove-box atmosphere, a change of surgeon's gloves every 15 to 20 min is recommended as a safe working procedure. (auth)

5547 (SB-448(Rev.)) AIR POLLUTION AND PURIFICATION. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). [nd]. 26p.

Three-hundred sixty-four references are presented to reports dealing with air pollution by fumes, industrial gases, smokes, and aerosols. A special section of Be air contamination is included. References to two air pollution bibliographies are included. (C.H.)

5548 (UCRL-7450) HAZARDS CONTROL QUARTERLY REPORT NO. 13, APRIL–JUNE 1963. (California. Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 55p.

A plot of radioiodines produced by thermal fission of U^{235} as a function of time after fission is presented, and a high-expansion fire control system for glove boxes using argon–aqueous ammonium lauryl sulfate foams is described. In development of analytical and measuring methods, an infrared spectrophotometric analysis of vapors in calibration bottles is reported along with modification of the Davis halide meter for continuous atmospheric monitoring of methyl chloroform and development of arc sensitivity conversion factors for use with a 3.4-meter spectrograph in the case of 33 elements. In other work a long-service sprayable polyurethane flooring material was developed which provides safety in high-explosive handling areas. Shielding for the proposed increased Cockcroft-Walton ion accelerator beam power level is discussed. Results of floor finish evaluations are given in which three were selected as superior in regard to anti-slip qualities, lasting appearance, and cost. The description of a method to convert from fail-safe fire detection circuit to a fully supervised circuit is included along with nomographs for simplification of air-sampling calculations. (J.R.D.)

5549 (JPRS-21975(Del.)) STUDIES OF RADIATION IN SANITATION. Translated from Gigiena i Sanit., 28: No. 9, 5–11; 97–8; 101–3(Sept. 1963). 17p.

Three papers are included; separate abstracts have been prepared for two. (H.M.G.)

For abstracts of individual papers see: 5483 and 5697.

5550 THE RETENTION TIME OF Sr^{90} IN THE STRATOSPHERE. Victor Mageru and Dragos Blanariu. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 14: 59-62(1963). (In Romanian)

The residence time of Sr^{90} in the stratosphere is calculated from data obtained at Jassy, Rumania. Because the quantity and frequency of precipitation varies each month, the monthly mean values of the Sr^{90} concentrations fluctuate strongly. Thus, two-month mean values are used in the calculations of the Sr^{90} concentrations in rain water. The concentration of Sr^{90} in the rain water is determined using published curves (Hunter and Ballou, Nucleonics 9: C-2 (1951)), assuming that all the activity is a result of a single massive injection of radioactivity into the stratosphere sometime about autumn, 1958. Using an exponential relation for the temporal variation of the activity, it is calculated that the half life of Sr^{90} is 0.44 ± 0.06 yr and the retention time in the stratosphere is 0.7 ± 0.11 yr. (tr-auth)

5551 BETA RADIOACTIVITY OF RAIN WATER IN THE R.P.R. DURING THE PERIOD JANUARY 1, 1961 TO OCTOBER 1, 1962. Victor Mageru. Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn., 14: 63-74(1963). (In Romanian)

A study is made of the radioactivity carried to the soil by precipitation during 1961 and 1962. Meteorological criteria used in determining the sites for the six sampling stations are reviewed, and the working techniques are outlined. The ten-day and monthly mean values of the specific β activities of the precipitation are represented graphi-

cally. The graphs show similarities that group the sampling stations into two groups. The graphs further show the presence of a spring maximum. During 1961 the specific activities are mostly in the range of 10 to 100 pC/liter, and during 1962 in the range of 100 to 500 pC/liter. This increase in the specific activity is explained in terms of the displacements of air masses in the rain-generating regions. (tr-auth)

5552 FALLOUT FILTERS... FOR WATER-PUMPING STATIONS IN CRITICAL AREAS. Jess Buckner. Am. City, 78: 107-8(June 1963).

Spun-fiberglass air filters were constructed for Oak Harbor's water pumping stations. The underground supply is protected by nature from radioactive fallout and the air filters were designed to prevent contamination of the water through the air supply of the gasoline powered engines to be used in the pumping process if the mainland power supply were inoperative. Fiberglass filters were also installed on the air vents of the ground-level water-storage tanks. The details of construction of the filters are presented. (Public Health Eng. Abstr., 43: No. 11, 1963)

5553 ANTICIPATED BIOLOGICAL AND ENVIRONMENTAL EFFECTS OF DETONATING A TWENTY-MEGATON WEAPON ON COLUMBUS CIRCLE IN NEW YORK CITY. Tom Stonier (Manhattan Coll., New York). Comment by Merril Eisenbud and F. W. Farrell. Ann. N. Y. Acad. Sci., 105: 287-382(Aug. 15, 1963).

The short-term effects that would result from the detonation of a single, relatively large, thermonuclear weapon on (or above) a single city are postulated. The potential economic, social, and biological disruption which are likely to constitute the sequelae to thermonuclear war are considered. However, the contention that nuclear weapons constitute the greatest threat to public health encountered in the recorded history of man becomes self-evident when one considers that the number of mortalities that would be caused by the Columbus Circle burst alone would be of the order of a magnitude greater than the combined battle deaths of all the wars ever fought by the United States. The problem of how best to meet this threat, and, specifically, the function of the scientific community as regards this problem, is considered briefly. (C.H.)

5554 LOCATION AND EXAMINATION OF ALPHA-ACTIVE AIRBORNE DUST PARTICLES COLLECTED ON GLASS-FIBER FILTER PAPER. D. C. Stevens (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Ann. Occupational Hyg., 6: 31-8(Jan.-Mar. 1963).

A procedure is described for the location and examination of radioactive particles by autoradiography. The procedure was applied to samples collected in laboratories handling toxic α emitters in order to provide data on the size of active dust particles escaping from glove boxes and other remote handling facilities under normal working conditions. The method described is of limited value for β-active particulates due to difficulties in precise location. The filtering characteristics of glass fiber paper used (Type AGF/A) make it a very suitable collecting medium for air sampling. The filter paper is mounted in a cold-setting Araldite mixture and a nuclear emulsion film is floated on to the surface. Processing of the emulsion is completed while it is still in contact with the mount; in this way an unambiguous alignment of the active dust particle with its α tracks is obtained. The direct information obtained includes location, size, and number of α-active particles in the presence of inactive dust. A count of the number of tracks from each particle permits an estimation of the activity-size distribution of the radioactive aerosol. A rough value of the specific activity of the particles can be calculated from exposure time and number of tracks per particle if a value for particle density is assumed. Information on specific activity may assist in identifying an unknown radionuclide. If the nuclide is known, a rough measure of specific activity can distinguish between particles of pure nuclide and contaminated dust. By measuring the radius of the track system (star) produced by an active particle and the depth of the particle below the emulsion, the range of the α particles in Araldite was calculated. The radius was measured using an eye-piece graticule calibrated against a stage micrometer, and the depth by means of the scale on the microscope fine focus drum. For 5.14-Mev α particles from Pu^{239}, the range in Araldite of density 1.0 g/cm^3 is about 33 μ while for U (energy 4.18 Mev) the range is about 23 μ. The method was found useful to confirm specific activity estimates, and for distinguishing small amounts of Pu on inert particles and particles of U compounds. (BBB)

5555 REMOVAL OF RADIOACTIVITIES DEPOSITED ON LEAFY VEGETABLES. Noboru Yamagata (Inst. of Public Health, Tokyo) and Kiyoshi Iwashima. Bull. Inst. Public Health (Tokyo), 12: No. 1, 1-6(Mar. 1963).

Tests were conducted in Japan on the effectiveness of water and several kinds of popularly used detergents to remove cesium-137, strontium-yttrium-90, iodine-131, zirconium–niobium-95, and radioruthenium artificially deposited on leafy vegetables. Detergents examined were 0.1 and 1% solution of sodium tripolyphosphate, 0.25% solution of commercial sodium alkyl benzene sulfonate (ABS), 1.3% solution of edible vinegar, 0.01N acetic acid, 0.25% solution of polyoxyethylene nonyl-phenyl ether, and 0.1% solution of sodium salt of ethylenediaminetetraacetic acid. The procedure recommended for decontamination is washing the vegetables with water for 2 minutes, then washing them with 1% solution of polyphosphate for 2 minutes, and, lastly, washing them with water. ABS or vinegar could be substituted for polyphosphate, but polyphosphate is preferred. Contaminated leafy vegetables obtained on the market were also examined by use of a gamma spectrometer. The lesser effectiveness observed in the removal of zirconium–niobium-95 from the vegetables, compared with those in the laboratory experiments, was attributed to the longer exposure of the market vegetables to contaminated air and rain, which caused the penetration and fixation of radioactive materials in the edible tissues. (Public Health Eng. Abstr., 43: No. 11, 1963)

5556 THE CONTROL OF FOOD SUPPLIES EXPOSED TO FALLOUT. E. E. Ballantyne. Can. J. Public Health, 54: 262-6(June 1963).

The control of food supplies that may be contaminated by a nuclear-bomb detonation is discussed. Both the short- and long-term situations are reviewed in terms of a post-attack recovery program. The emergency plan to safeguard food supplies and the necessary quarantine procedures to assure a safe, wholesome food supply are analyzed. (Public Health Eng. Abstr., 43: No. 11, 1963)

5557 AREA-WIDE DISASTER PLANNING. Dan G. Kadrovach (Brooke Army Medical Center, Fort Sam Houston, Tex.). Hospitals, 36: 45-8(Nov. 16, 1962).

The role of hospitals in ensuring national survival in the event of thermonuclear war is surveyed. The hospital has three primary responsibilities in disaster planning: to be prepared for local disaster, to be prepared to make a substantial contribution in disaster involving thermonuclear weapons, to be prepared to protect its personnel from the

hazards of fallout. Hospital preparations for mass casualties resulting from thermonuclear warfare require area-wide planning. As a model situation, this concept of area-wide planning is applied to San Antonio. Maximum utilization of hospital services in surrounding zones is discussed. It is suggested that a hospital complex should surround the target area. (BBB)

5558 CASUALTIES FROM NUCLEAR WEAPONS: A MANUAL FOR EMERGENCY HEALTH SERVICES, CANADA. F. C. Pace and W. R. Waters (Dept. of National Health and Welfare, Ottawa). Med. Serv. J. Can., 19: 219-46(Apr. 1963).

Preliminary to an outline of protective measures to be employed in a thermonuclear attack, the following topics are discussed: nuclear phenomena and explosions, ionizing radiations from nuclear weapon detonations, and their blast and thermal effects. From these discussions it is concluded that, within the target area, the causes of death and injury are mainly blast and heat. Radioactive fallout and its effects are discussed, as is the problem of handling massive numbers of casualties. Estimated values are given for types of disease incidence based on the assumptions of heavy nuclear attack and of minimal preventive action. Expected frequency and handling of various types of burns (flash, flame, retinal, and periocular) are considered in detail, as are the prevention and treatment of blast injuries. (BBB)

5559 REALISM IN DISASTER EXERCISES—A TRUE CHALLENGE. Ralph P. Campanale (Travis Air Force Base, Calif.). Military Med., 128: 418-27(May 1963).

A detailed description is provided of human responses to a realistically simulated disaster test in which an aircraft carrying radioactive material had apparently crashed into a barracks area. Following the apparent crash, an explosion and scattering of radioactivity throughout the area were simulated, and casualties with realistically feigned burns and injuries were employed to act out the role of the wounded. A critique of the human responses stresses the inertia and lack of initiative observed at the disaster site on the part of most medical corpsmen and some medical officers, as well as a total lack of field leadership and supervision. This lack of command supervision was evident not only in medical operations but on the part of other base agencies, without the presence of an overall commander. It is concluded that except for a real-life disaster situation only the most realistically simulated disaster exercises can provide the training and planning essential to establish and maintain a state of disaster readiness. (BBB)

5560 PREPARATION OF THE PROTECTION NORM FOR A "HOT OPERATION LABORATORY." C. Cortissone (CNEN, Rome). Minerva Nucl., 7: 353-62(Sept. 1963). (In Italian)

The manual on radioactivity for the hot operations laboratory of the Center for Nuclear Studies of the CNEN at Casaccia (Rome) is presented. The presentation of the manual offers the opportunity for a complete description of the laboratory and the operations that can be carried out in it. An extract from the manual is given in an appendix. (auth)

5561 DECONTAMINATION OF THE ROOMS OF A U–Th METALLURGICAL DEPARTMENT, FOR TRANSFORMATION TO ORDINARY INDUSTRIAL USE. C. Cortissone and S. Tagliati (CNEN, Rome). Minerva Nucl., 7: 363-9(Sept. 1963). (In Italian)

The decontamination of a U–Th metallurgical laboratory that was transformed for ordinary industrial uses is described. The principles and methods used in this laboratory and the conditions present after four years of metallurgical operation are described. The means used for decontamination and the various steps in this operation are illustrated. The results are given and discussed. (auth)

5562 ACTIVITY MONITORING IN THE HOT AND ISOTOPE LABORATORY. P. Graf (EIR, Wurenlingen, Ger.) and F. Humbel. Neue Tech., 5: 537-41(Sept. 1963). (In German)

The purpose of radiation monitoring in a hot laboratory is the protection of personnel, the general population, and the vegetation from the damaging effects of radiation. The personnel monitoring system, space monitoring, γ monitoring in the hot cells, monitoring of the exhaust air, and activity control of the liquid wastes by α, β–γ, and γ measurements are described. (J.S.R.)

5563 EXPERIMENTAL TECHNIQUE WITH PLUTONIUM. H. Schumacher (EIR, Wurenlingen, Ger.). Neue Tech., 5: 547-51(Sept. 1963). (In German)

Pu is an α emitter, is highly inflammable and pyrophoric, and reaches criticality with a relatively small mass. The radiation protection precautions (air-tight glove boxes), the use of inert atmospheres, and criticality control are described. The microchemical methods used in the weighing, metallurgy, and separation and purification of micromasses of Pu are discussed. (tr-auth)

5564 PLANCK, RAD, ROENTGEN, AND RHO. ZURICH PROPOSALS FOR RADIOLOGICAL UNITS. Hans R. Schinz and Rolf Wideroee. Strahlentherapie, 122: 408-15 (Nov. 1963). (In German)

The different nature of radiometric and dosimetric values must be realized in order to clarify discrepancies in the interpretation of medical radiation measurement. The rad has been used as special unit of dosage since 1953. It was recently proposed that the Planck be introduced as a unit in radiometry. One Planck = 3000 erg/cm^2. Using these two energetic units a complete system of units is obtained. The units Roentgen and Rho used for ionization measurements are purely technical parameters, which are used for the determination of the Planck- and rad-values. Misleading, however, is the practice that often identifies these parameters with the basic values. This is not allowed even if the numerical values agree in many of the cases. (auth)

5565 PUBLIC HEALTH RESPONSIBILITIES IN RADIATION PROTECTION (FOURTH REPORT OF THE EXPERT COMMITTEE ON RADIATION). E. J. Henningsen. World Health Organ. Tech. Rep. Ser., No. 254 23p.(1963).

Four general aspects of public health responsibilities in regard to radiation protection were discussed: identification and measurement of all sources of radiation exposure of the population; evaluation and assessment of these exposures in terms of biological hazard to exposed population groups, including stimulation and conduct of research; development and application of methods of control; and conduct of programs of professional and public information and education on the health impact of radiation sources. It is emphasized that it is the responsibility of the health agency to provide a single focal point for evaluation of the total health impact of all sources of radiation and to ensure that adequate measures for health protection are taken. It is suggested that as a first step towards evolving such a program, much can be gained by developing control measures even for a single source, such as the much-needed control of x-ray machines. Considered in detail are the

needs for and possible scope of new legislation to give agencies authority for an adequate program, and the administrative structure of such radiation health agencies. Examples of possible programs are outlined. General recommendations of the Committee are presented. (BBB)

5566 EFFECTS OF NUCLEAR EXPLOSIONS. John M. Fowler. p.94-114 of "Proceedings of Nuclear Energy Conference." [Russellville, Arkansas, Arkansas Polytechnic College, 1963].

The causes, consequences, and steps that lead to nuclear reactions and explosions are discussed. The construction, cost, efficiency, stockpiles, blast, heat, and fallout are considered. A hypothetical case of an actual attack on a target is also discussed. (P.C.H.)

5567 THE STRATEGY OF OVERKILL. Ralph E. Lapp. p.135-57 of "Proceedings of Nuclear Energy Conference." [Russellville, Arkansas, Arkansas Polytechnic College, 1963].

The origin and stability of deterrence is discussed. The present and projected levels of U. S. strategic deterrent power are also examined. (P.C.H.)

5568 CIVIL DEFENSE. Jack E. Wilson. p.158-68 of "Proceedings of Nuclear Energy Conference." [Russellville, Arkansas, Arkansas Polytechnic College, 1963].

The genesis of the national civil defense program, its organization, and mission are discussed. Shelter support systems including: a legal basis from which state and local governments can operate; and organizational capability; warning systems to provide notice of attack; control centers from which governments can conduct emergency operations; radiological monitoring systems; communications systems; emergency information systems; and a training capability to assure the technical and managerial skills required to use the systems are discussed. (P.C.H.)

5569 SHIPPING CONTAINERS (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1055)

This package contains 3 drawings. Shielded containers were developed to ship liquid isotopes. The modified 3-P radioisotope container is used with 15, 25, 50, 100, and 200 ml bottles. The space for the bottle can be from 1.688 in. in dia. to 2.906 in. with a depth of from 3.062 to 4.187 in. The carrier is 8.125 in dia. with the height varying according to the size of the bottle used. The modified 2-P radioisotope container is a stainless steel bottle container. For the 15 ml bottle it is 1.360 in. OD and 2.938 in. deep. The container for the 25 ml bottle is 1.660 in. OD and 3.438 in. deep. The carrier is 6.625 in. OD with the height varying according to the bottle size. The modified 52-P radioisotope container is made of stainless steel and is 7 in. OD with the height depending on the bottle container. For the 25 ml bottle the container is 1.660 in. OD and 3.438 in. deep. For the 15 ml bottle the container is 2.938 in. deep and 1.360 in. OD. (F.S.)

5570 PRODUCT RECEIVER CAN (Engineering Materials). (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (CAPE-1068)

This package contains 3 drawings. The product receiver cans are used for in-plant transfer of plutonium solutions at the Redox facility. The container sits on a 6.5 in. high base and is 2 ft 8 in. high, 22 in. OD with a wall 0.25 in. thick. The cans are 2 ft 3 in. high × 7.875 in. OD and made of stainless steel with lead fill. The cans do not have Bureau of Explosives' approval for transfer of plutonium solutions. Approval is required prior to use. (F.S.)

INSTRUMENTATION

General

5571 (AD-423673) VACUUM DEPOSITION OF THIN-FILM ELECTRONIC COMPONENTS: AN ANNOTATED BIBLIOGRAPHY. Scott J. Buginas, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Feb. 1963. 39p. (SB-63-15)

This bibliography contains 74 references primarily within the span 1960–1962. A few key items from earlier years have been included to fill in subject gaps. Superconducting films, carbon films, magnetic films, semiconductor films, and memory elements were not within the general parameters of the search. Conductors, connectors, resistors, and capacitors were of prime interest. (auth)

5572 (AEDC-TDR-63-187) A TECHNIQUE FOR MEASURING A LOCAL GAS DENSITY USING SCATTERED GAMMA RADIATION. J. E. Shepard and J. B. Dicks (Arnold Engineering Development Center, Tullahoma, Tenn.). Nov. 1963. Contract AF40(600)-1000. 43p. (AD-423150)

A method for direct density measurement of a gas without the use of material probes is proposed and the experimental investigation summarized. The operation of the gas density measuring instrument is based upon the interaction between a gamma-ray beam and the electrons in the gas as described by the Compton scattering principle. Experimental results indicate the practicability of this instrument for use in low density, high temperature wind tunnels and other high temperature gas flows such as rocket exhausts. (auth)

5573 (CONF-229-2) THIN FILM MEASUREMENTS BY X-RAY-EMISSION SPECTROGRAPHY. P. D. Zemany (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract [W-31-109-eng-52]. 18p.

From Eastern Analytical Symposium, New York, Nov. 1962.

The principles of x-ray absorptiometry in the measurement of thin film thicknesses are discussed. The simple absorptiometric method has limitations which are partially overcome by the absorption edge method and the oblique method for films on substrates. The x-ray emission method, which is based on secondary x rays emitted by the film, gives a direct measure of the film thickness, in contrast to the indirect measures of the absorptiometric methods. The critical thickness and the factors affecting it in the emission method are discussed. The emission method can be used for measuring individual elements in composite films of thickness varying from a monolayer up to many mg/cm^2. The ranges of application of the four described methods are discussed. (D.L.C.)

5574 (LADC-5896) INSTRUMENTATION AT THE LOS ALAMOS CRITICAL ASSEMBLY LABORATORY. Herbert H. Helmick (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 24p. (CONF-344-1)

From Meeting of the Institute of Electrical and Electronic Engineers, San Diego, Calif., Oct. 1963.

A summary is presented of the various types of electronic instrumentation used. Also discussed is automatic data handling equipment, as well as the nature of command and readout signals used on remote control critical assembly machines. Equipment is described for performing prompt neutron lifetime measurements, pile oscillator technique, and the power fluctuation experiment. (auth)

5575 (NP-13288) STUDY OF THE DYNAMIC BEHAVIOUR OF THERMOWELLS. J. Challe (European Company for the Chemical Processing of Irradiated Fuels, Mol., Belgium). Sept. 1962. 25p. (ETR-139)

The transient response of oversized thermowells, temperature measuring devices consisting of thermocouples soldered to the base of a protective metal sheath, was investigated analytically and experimentally. The solution, with respect to time, of an approximate version of the heat conductivity transfer equation is compared with the actual transient curves. Various methods by which the frequency response of linear systems can be derived from their response to a unit step input are briefly described and discussed. (auth)

5576 (SC-DR-260-63) DC POWER SUPPLY FOR FERROELECTRIC LOOP GENERATION. J. L. Wentz and C. W. Boots (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 14p.

A voltage source capable of producing ±10 kv d-c at 0.01 mamp for tracing hysteresis loops of ferroelectric ceramic materials is described. The amplitude-time relation is produced by manual control. The instrument features simplicity of construction, ease of operation, and reliability of performance and can also serve as an ordinary power supply where a reversible polarity is desired. (auth)

5577 (UCRL-Trans-1004(L)) DETERMINATION OF THE CORRECTION FOR THERMAL INERTIA OF THE CALORIMETER DURING CALORIMETRIC MEASUREMENTS OF RADIOACTIVE PREPARATIONS. N. S. Shimanskaya. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Tr. Radievogo Inst., Akad. Nauk SSSR, 9: 126-30(1959). 7p.

An equation is derived for the correction factor $K_\lambda \leq 1$ for the case of the static calorimeter. A table and a nomograph are given for finding K_λ at different values of thermal inertia of the calorimeter and half life of the source being measured. (D.L.C.)

5578 QUANTITATIVE EVALUATION OF γ SPECTROGRAM. W. Kolbe and F. H. Rinn (Siemens and Halske AG, Karlsruhe, Ger.). Atomkernenergie, 8: 394-9(Nov. 1963). (In German)

It is shown what accuracy can be expected quantitatively during the recording of spectra with a finite constant absolute channel width. The finite channel width has an effect that causes the measuring function $\bar{n}(x)$ to be not exactly equal to the spectral function $n(x) = -N'(x)$. The deviation is proportional to the curve curvature. The estimation of the error and its correction are done in such a way, or the recording conditions are chosen in such a manner, that the measuring error becomes sufficiently small to be negligible. (The channel width must be small as compared to the line width.) It is proven that the integral pulse number is equal to the surface below the spectral curve. The error caused by the finite channel width can be avoided if the beginning and end of the evaluated range are located at horizontal curve fragments or points of equal inclination. Spectrograms of constant relative but practically disappearing channel width are considered. The spectrum, that is, the differential pulse frequency is no longer recorded during this process. In the case of a linear energy scale, it is still possible to determine the integral pulse number

of photo peaks accurately. The formulas for the necessary corrections are stated. For other curve fragments (Compton range), the pulse can only be determined approximately by segments. Some methods for the development of a constant relative channel width give a non-linear energy scale. The distortions which occur furthermore, make a quantitative evaluation practically impossible. The proportionality between pulse number and curve surface can be restored by an exponential energy course. (auth)

5579 MEASUREMENT OF SHORT TIME INTERVALS IN NUCLEAR PHYSICS. Armand Sarazin and Jean-Jacques Samueli (Université, Lyon). Ind. At., 7: Nos. 9-10, 74-82 (1963). (In French)

The methods used in nuclear physics for the direct measurement of time intervals of the order of the nanosecond and particularly for the measurement of the lifetime of low-energy nuclear states are reviewed. Fast electronic techniques, theory of time resolution, and mathematical methods of calculating results are successively studied. (auth)

5580 CALCULATIONS FOR MAGNETIC SPECTROMETERS WITH CIRCULAR CONFINEMENT. N. G. Afanasev, A. V. Vysotskaya, and V. A. Goldshtein (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekhn. Eksperim., No. 5, 29-33(Sept.-Oct. 1963). (In Russian)

Equations are given for the first and second order double focusing and range of the scattering field of a real magnet. A method is presented for refining the resolving power of a spectrometer with a large solid angle. The results are analyzed for selection of the basic parameters of the spectrometer such as the deflection angle, the position of the source and image with respect to the magnet, the resolving power, and the illuminating power of the spectrometer. (tr-auth)

5581 ABERRATION OF A MAGNETIC SPECTROMETER WITH CIRCULAR CONFINEMENT. N. G. Afanasev, A. V. Vysotskaya, and V. A. Goldshtein (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). (Pribory i Tekhn. Eksperim., No. 5, 34-9(Sept.-Oct. 1963). (In Russian)

Expressions are given for second and third order aberrations of a magnetic spectrometer with uniform field and circular confinement. The range of the scattering field is also calculated. (tr-auth)

5582 WORK ON ELECTRON COLLIMATION WITH THIN FOILS COVERED WITH INACTIVE FILMS. V. F. Mikhailov (Inst. of Geology, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 49-50(Sept.-Oct. 1963). (In Russian)

Equations are presented that take into account the effects of the inactive film that often covers radioactive foils used in electron collimation. The calculations can also be used to determine the electron drift velocity in the chamber. (tr-auth)

5583 PRODUCTION OF NANOSECOND PULSES WITH VERY HIGH FREQUENCY OSCILLATIONS. S. I. Andreev, B. M. Lebed, and B. M. Sokolov. Pribory i Tekhn. Eksperim., No. 5, 123-4(Sept.-Oct. 1963). (In Russian)

A method for production of v-h-f pulses by means of a wide-banded ferrite modulator is described. For sinusoidal variations to control a magnetic field with a range exceeding 20 oersteds, the modulator forms electromagnetic pulses with a frequency of 9.4 BHz and a duration that can be changed from 10-400 nsec. (tr-auth)

5584 DEVICE FOR INVESTIGATION OF ELECTRON SPIN-LATTICE RELAXATION AT LOW TEMPERATURES WITH FREQUENCY OF 9 BHz. Ya. L. Shamfarov (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian, SSR). Pribory i Tekhn. Eksperim., No. 5, 134-8(Sept.-Oct. 1963). (In Russian)

An apparatus for investigation of electron spin-lattice relaxation at low temperatures, by a method of pulse inversion by means of sinusoidally modulated pulses of a magnetic field, is described. The technique of inversion of the level population of the spin system is discussed. The device permits the measurement of the relaxation time in the range $1\text{-}10^{-3}$ sec with an error not exceeding ±10%. (tr-auth)

5585 METHOD FOR INVESTIGATING THE STABILITY OF VENETIAN-BLIND TYPE PHOTOMULTIPLIER TUBES. G. S. Vildgrube, N. K. Dalinenko, N. V. Dynaevskaya, and Zh. M. Ronkin. Pribory i Tekhn. Eksperim., No. 5, 167-72(Sept.-Oct. 1963). (In Russian)

The stability of photomultiplier tubes FEU-11, 12, 13, 14, 15, 16, 49, 52, 53, 54, 55, and 56 is investigated. A brief description is given of the measuring equipment and the method used. The sources of instability in the photomultiplier tubes are discussed. (tr-auth)

5586 INVESTIGATION OF SINGLE-ELECTRON NOISE IN PHOTOMULTIPLIER TUBES. A. N. Pertsev, A. N. Pisarevskii, and L. D. Soshin (Belorussian State Univ., USSR). Pribory i Tekhn. Eksperim., No. 5, 173-6 (Sept.-Oct. 1963). (In Russian)

The natural noise of several photomultiplier tubes was investigated. It is shown that the statistical distribution can be described by Poisson's principle. Conditions are found for reducing the noise almost to the order of single-electron noise pulses. (tr-auth)

5587 DEVICE FOR MEASURING ELECTRON BEAM PARAMETERS. A. M. Minkin. Pribory i Tekhn. Eksperim., No. 5, 177-9(Sept.-Oct. 1963). (In Russian)

A device for simultaneously measuring the form of the cross section and current density distribution at any location in an electron beam is presented. The device has a target with openings that are arranged for secondary electron multiplication. The measuring scheme is a type of television equipment. The method of separation of lines is used for measuring current density distributions in the beam. The precision of the method is compared with existing methods. The efficiency of the apparatus is discussed. (tr-auth)

5588 THICKNESS MEASUREMENTS FOR FOILS AND FILMS BY MEANS OF THE $(\alpha,n\gamma)$ REACTION. I. N. Plaksin, M. A. Belyakov, and L. P. Starchik. Pribory i Tekhn. Eksperim., No. 5, 210-11(Sept.-Oct. 1963). (In Russian)

A method for determining the thickness of foils and films based on the $Be^{9}(\alpha,n\gamma)$ reaction is presented. The foil to be measured is placed between a Po^{210} α source and a beryllium oxide target and the resulting neutrons and γ rays recorded. (C.E.S.)

5589 OPTICALLY PUMPED NUCLEAR MAGNETOMETER. L. D. Schearer, F. D. Colegrove, and G. K. Walters (Texas Instruments Inc., Dallas). Rev. Sci. Instr., 34: 1363-6(Dec. 1963).

A continuous recording total earth's field magnetometer is demonstrated that utilizes optical pumping in He^{3} and the resultant polarization of the nuclear spins. The device operates as a self-oscillator at the Larmor frequency of the ground state atoms. The oscillator has a Q of 10^{4} in a 0.5-G field. The sensitivity of the instrument to fluctua-

tions in the magnetic field is presently several microgauss. The characteristics and operating principles of the instrument are described. The application of the device to the measurement of the absolute value of the total external magnetic field is discussed. (auth)

5590 CONTINUOUS ION SOURCE FOR A TIME-OF-FLIGHT MASS SPECTROMETER. Martin H. Studier (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 1367-70 (Dec. 1963).

Improved performance of continuous ion sources in a time-of-flight mass spectrometer was obtained. The system was developed for use with heated filament surface ionization sources; however, the advantages of its use with an electron bombardment source seem more significant. With an electron gun operating continuously, a factor of 300 increases in sensitivity over that of the pulsed mode of operation is attained with improved resolution and no increase in the ratio of noise to signal. (auth)

5591 MODIFIED POLAROID FILM HOLDER FOR X-RAY AND NEUTRON DIFFRACTION. H. G. Smith and D. L. Holcomb (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 34: 1441(Dec. 1963).

A modified film holder used in the recording of x-ray and neutron-diffraction patterns is described. The holder was developed for the Buerger precession camera and is used chiefly for Laue photography. (R.E.U.)

5592 ELECTRON MONOCHROMATOR UTILIZING THE SCATTERING RESONANCE IN HELIUM. J. Arol Simpson, C. E. Kuyatt, and S. R. Mielczarek (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instr., 34: 1454-5(Dec. 1963).

A apparatus is described that makes use of the 19.3-ev electron resonance in helium for monochromatizing an electron beam. The apparatus consists of an electron gun, followed by two differentially pumped interaction chambers containing helium and a Faraday cage electron collector. (R.E.U.)

5593 DESIGN OF SECOND ORDER DOUBLE FOCUSING MASS SPECTROMETERS. Hirohiko Ezoe, Tomonao Hayashi, Takashi Shikata, Katsusuke Yamane, and Yoshiko Kuniyoshi. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 138-43(Sept. 1963).

Analytical results given by Hintenberger were studied numerically with an electronic computer, and physically realizable solutions were computed systematically. Corresponding to these solutions, the inclinations and the radii of curvature of the first-order focusing loci were also computed and the design data were tabulated. On two examples of these instruments the aberrations caused by dimensional errors were estimated. (auth)

5594 DISTORTIONS CONTRIBUTED BY DELAY CURVES IN TRI-ELECTRODE ANALYZERS. A. M. Tyutikov and Yu. A. Shapiro. Zh. Tekhn. Fiz., 33: 1265-73(Oct. 1963). (In Russian)

A theoretical analysis was made of grating induced distortions in delay curves of tri-electrode analyzers used for determining electron velocities. Experimental data are in agreement with theory. (R.V.J.)

5595 ELECTRONIC COMPONENTS (LASL) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1042)

The 46 engineering drawings in this package describe electronic components developed by the Los Alamos Scientific Laboratory. These components include scalers, toepler pump controls, amplifiers, pulse analyzer, pulser, and power supplies. (F.S.)

5596 FAST SHUTTER ASSEMBLY, MODEL II (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1063)

This package contains 3 drawings. The shutter assembly is connected to a 14-μf, 20-kv capacitor which has a low-inductance ignitron switch header with 2 output cables. The shutter was measured to close from full light to zero light in 8 μsec while operating at atmospheric pressure. It should be faster when operated in a vacuum. To actuate the shutter, light which is collimated at an angle through a series of slits passes by the top edge of a thin leaf spring. When the spring moves in one direction, its cross section interrupts the light and acts as a shutter. The spring is moved by a fast-rising magnetic field, which is generated by passing a large current through the spring. The current passes through a rigid conductor on one side across a short, and back through the leaf spring. The current flowing in opposite directions generates a magnetic field which repels the two conductors. The spring, because of its small mass, is moved away from the rigid conductor in the direction to interrupt the light beam. (F.S.)

5597 METHOD OF DETERMINING THE QUANTITY OF LIQUID IN CONTAINERS BY MEANS OF NEUTRONS. Kurt Diebner. British Patent 938,233. Oct. 2, 1963. Priority date July 30, 1959, Germany.

A method is described for continuously determining the quantity of liquid in container independently of the shape or position of the container or the height of the liquid level. The liquid is irradiated with fast neutrons, and the quantity of thermal neutrons, resulting from fast neutrons being braked in the liquid, striking a detector per unit time serves as a measure of the liquid quantity. Controllable neutron sources based on the reactions D−D, D−T, (p,n), (d,n), (γ,n) are suggested. A filter that transmits only fast neutrons is interposed between the neutron source and the container. One or more counter tubes or scintillation counters are used as thermal-neutron detectors. The method is particularly suitable for establishing the quantity of fuel in the tanks of aircraft and other vehicles. (A.G.W.)

5598 IMPROVEMENTS IN OR RELATING TO MEASURING SYSTEMS. Jack George Crump (to Industrial Nucleonics Corp.). British Patent 938,441. Oct. 2, 1963. Filed July 6, 1961.

Apparatus is described for measuring the fill height of material in containers by means of a source of penetrating ionizing radiation located on one side of the containers and detecting means for radiation located on the other side of the containers. The detecting means comprises a plurality of elongated detector tubes mounted substantially in a plane that also passes through the radiation source and through the level of the desired fill height of the containers. The radiation source comprises a thin film of radioactive material deposited on a flat surface with the minimum dimension of the source directed toward the detectors. Conveyor means are provided for passing the containers between the source and the detecting means. The detecting tubes are Geiger-Mueller tubes staggered in the direction of travel of the containers. Positioning means for the source and the detector are adapted to displace the detector relative to the source diagonally in the direction of travel of the containers in such a manner that a continuous absorber is provided between the source and the detector. (A.G.W.)

5599 A MEASURING CELL FOR AN ELECTRICAL MASS FILTER. (to Siemens-Schuckertwerke AG). British Patent 938,667. Oct. 2, 1963. Priority date Mar. 9, 1960, Germany.

In the measuring cell described, an ion source, an analyzer part, and an ion current collector are axially aligned within a tubular envelope, which has a middle part and two end parts all of glass. Two metallic intermediate pieces, one between the middle part and one end part and the other between the middle part and the other end part, are connected vacuum-tight to the glass parts. The analyzer part may have analyzer rods, entry diaphragms, and exit diaphragms formed as a self-contained, preset unit, which at one end is rigidly secured to one of the metallic pieces of the envelope and at the other end is held by an annular resilient member, electrically conducting and centered against the other metallic piece. The analyzer rods may also be held in predetermined relative positions by insulator rings at their ends. The individual glass parts of the envelope may be interconnected by fused-on metal flanges soldered or welded together. At these places, a detachable flange connection, using inserted metal packing rings, may also be provided. In use of the measuring cell at high pressures (above 10^{-4} mm Hg) of the gas to be measured, a cold ion source may be provided. One of the glass end parts may be formed as a base on which the apparatus may be stood vertically. The device is particularly suited for use at gas pressures below 10^{-4} mm Hg as a partial pressure vacuum gage. (A.G.W.)

5600 NEGATIVE ION SOURCE. Raymond G. Herb and James A. Weinmann (to High Voltage Engineering Corp.). German Patent 1,156,515. Oct. 31, 1963. Priority date Apr. 9, 1956, United States.

A negative ion source, e.g., for use with an ion accelerator, is provided. It consists of an evacuated chamber and an electrode supported within the chamber. The electrode has a capillary through it. A gas is introduced into the capillary at some point between its extremities, and a beam of positive ions is axially directed into the gas in the capillary so that negative ions are produced by the interaction of the positive ion beam and the gas. (Gmelin Inst.)

5601 X-RAY SPECTROGRAPH. Joshua Ladell and Nathan Spielberg (to North American Philips Co., Inc.). U. S. Patent 3,102,196. Aug. 27, 1963. Filed Nov. 23, 1959.

The x-ray spectrograph described employs a crystal prepared to reflect each wavelength at an angle determined by the reciprocal lattice construction of the crystal. The crystal is also deformed into a curved surface so as to converge each of these wavelengths at a point on a focusing circle. Detectors placed at suitable positions on the circle permit simultaneous recording of all wavelengths. (A.G.W.)

5602 ADIABATIC BEAM CONDENSER METHOD AND APPARATUS. Peter A. Sturrock (to Varian Associates). U. S. Patent 3,102,211. Aug. 27, 1963. Filed Aug. 19, 1959.

The adiabatic beam condenser described is physically longer than one beam-focusing wavelength and may be matched at the input end to the gun assembly and at the output end to the beam utilization circuit. It includes means for progressively increasing the beam focusing force down the length of the beam condenser and thereby increasing the current density of the beam. The beam is delivered to the utilization circuit without introduction of excessive aberrations and without appreciable gain or loss of energy. (A.G.W.)

5603 PHOTOMULTIPLIER PULSE SHAPING CIRCUIT. Jasper E. Richardson and William R. Orr (to Shell Oil Co.). U. S. Patent 3,102,954. Sept. 3, 1963. Filed Dec. 8, 1959.

An output circuit for a photomultiplying tube of a scintillation-type radiation detector having two phosphors with different decay times is described. In the circuit separate signals are removed from the dynode and from the anode of the photomultiplier tube. The two signals are passed through separate circuits and then algebraically combined at a junction point. Where the photomultiplier views a composite phosphor, the signal may be separated into its individual components. Pulses are thus trimmed and shaped to provide desired wave forms. (A.G.W.)

5604 NUCLEAR GYROSCOPE. Ivan A. Greenwood, Jr. (to General Precision, Inc.). U. S. Patent 3,103,623. Sept. 10, 1963. Filed Apr. 19, 1960.

Devices for sensing rotation relative to an inertial frame are described. Two magnetic gaps having unidirectional magnetic fields parallel to each other but oppositely directed are employed. The magnetic gaps are formed in a magnetic structure rigidly associated with the remainder of the apparatus. A nuclear sample is positioned in each field. Each sample contains nuclei of the same two kinds. Apparatus is employed for exciting the nuclei and deriving from them nuclear magnetic resonance signals. By phase comparison methods, one pair of the four signals is fed back to control the magnetic field strength is such a way that any requirement for independent knowledge of the absolute field magnitude is eliminated. From the other pair of signals, there is derived a signal representing the integral of the rate of rotation of the apparatus about one of its magnetic field directions. The same principles may be used in a device having three degrees of freedom, which determines the integrals of the three angular rates of rotation relative to the fixed star frame. In this device at least four nuclear samples of two kinds of nuclei are employed in at least four magnetic fields. (A.G.W.)

5605 NUCLEAR GYROSCOPE. Ivan A. Greenwood, Jr., John R. Lowdenslager, and James H. Simpson, Jr. (to General Precision, Inc.). U. S. Patent 3,103,624. Sept. 10, 1963. Filed Apr. 20, 1960.

Devices for sensing change of direction or rate of rotation relative to an inertial frame are described. A single homogeneous unidirectional magnetic field is employed. A single sample of fluid material containing two selected kinds of atomic nuclei is placed in the magnetic field. Apparatus is provided for producing nuclear magnetic resonance signals from the two kinds of nuclei. From these two signals is derived a single signal representing angular change of position of the apparatus relative to inertial or fixed star coordinates. No independent knowledge of the absolute magnetic field magnitude is required, and variations in the field strength have no first-order effect on the accuracy of the output. (A.G.W.)

5606 HIGH SPEED KERR CELL FRAMING CAMERA. Willis C. Goss and Leroy F. Gilley (to U. S. Atomic Energy Commission). U. S. Patent 3,116,660. Jan. 7, 1964.

The present invention relates to a high speed camera utilizing a Kerr cell shutter and a novel optical delay system having no moving parts. The camera can selectively photograph at least 6 frames within 9×10^{-8} seconds during any such time interval of an occurring event. The invention utilizes particularly an optical system which views

and transmits 6 images of an event to a multi-channeled optical delay relay system. The delay relay system has optical paths of successively increased length in whole multiples of the first channel optical path length, into which optical paths the 6 images are transmitted. The successively delayed images are accepted from the exit of the delay relay system by an optical image focusing means, which in turn directs the images into a Kerr cell shutter disposed to intercept the image paths. A camera is disposed to simultaneously view and record the 6 images during a single exposure of the Kerr cell shutter. (AEC)

Radiation Detection

Refer also to abstracts 5211, 6161, and 6163.

5607 (BNL-7478) BUBBLE CHAMBER VACUUM SYSTEM. C. Gould (Brookhaven National Lab., Upton N. Y.). Jan. 13, 1961. Contract [AT(30-2)-Gen-16]. 4p.

The vacuum system for a bubble chamber must evacuate rapidly a volume of approximately 500 cubic feet and eliminate the outgassing of a surface area of approximately 50,000 in^2. Fourteen inch aperture flanges serve to connect the vacuum plumbing to the chamber. It was proposed to use two 14-in. mainfolds from these flanges, with each manifold accommodating two diffusion pumps. (M.C.G.)

5608 (CERN-63-34(p.7-15)) A GENERAL EXPLANATION OF HAZE INCLUDING DIFFERENCES BETWEEN LRL, BNL AND CERN. D. Hall (California. Univ., Berkeley. Lawrence Radiation Lab.).

The HAZE program used in measuring bubble chamber photographs with the flying spot digitizer (FSD) system is discussed, following a brief review of FSD operation. (D.C.W.)

5609 (CERN-63-34(p.17-27)) FSD OPERATING EXPERIENCES AT BERKELEY. D. Hall (California. Univ., Berkeley. Lawrence Radiation Lab.).

The performance of the flying spot digitizer system in measurements on 4200 bubble chamber events is discussed. (D.C.W.)

5610 (CERN-63-34(p.29-40)) A METHOD OF FILTERING HPD DATA USING "TRACK FOLLOWING." J. W. Burren and M. J. Mitchell (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England).

A system of dividing the picture into track segments of 32 scan-lines and filtering all roads after each segment is used. Choice of segment length, gating of segments, and filtering are described. Performance of the program is summarized. (D.C.W.)

5611 (CERN-63-34(p.41-56)) PROGRAMMING FOR THE SMP. W. Humphrey (California. Univ., Berkeley. Lawrence Radiation Lab.).

The operation and structure of the programs for the Scanning-Measuring Projector system are discussed. (D.C.W.)

5612 (CERN-63-34(p.57-66)) OFF LINE TREATMENT OF HPD DIGITIZINGS. M. Bloch and M. Schiff (Paris. Université).

A Hough-Powell flying spot digitizer system with off-line treatment of the digitizing is outlined, and the program for the off-line treatment of the tracks is described. (D.C.W.)

5613 (CERN-63-34(p.67-75)) PERFORMANCE OF THE FIDUCIAL-FINDING SUBROUTINE H-10. P. V. C. Hough (Brookhaven National Lab., Upton, N. Y.).

Preparation of fiducial marks at the chamber, the precision and operational mode of the subroutine, diagnostics, and problems are discussed. Fiducials observed in the production and decay of a cascade and anticascade particles are shown along with the fiducial coordinates found by H-10. (D.C.W.)

5614 (CERN-63-34(p.77-83)) CONTROLLED FILTER AND SMOOTHING. D. Burd (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.) and N. Webre (Brookhaven National Lab., Upton, N. Y.).

CONTROLLED FILTER displays, method, and performance are discussed; and the smoothing process by which errors in CONTROLLED FILTER results are corrected or detected is described. (D.C.W.)

5615 (CERN-63-34(p.85-93)) ADAPTATION OF FOG AND CLOUDY TO HAZE. D. Hall (California. Univ., Berkeley. Lawrence Radiation Lab.).

Changes associated with the multiprogramming are discussed along with the additional programming required for making use of ionization information. (auth)

5616 (CERN-63-34(p.95-109)) THE CERN VERSION OF MIST. S. J. McCarroll (European Organization for Nuclear Research, Geneva).

The computer program MIST, which processes the data punched on the CERN scan tables and produces an input tape for HAZE for use with the Hough-Powell digitizer and the GRIND and THRESH programs, is described. (D.C.W.)

5617 (CERN-63-34(p.111-24)) ADAPTATION OF THRESH AND GRIND FOR HPD. J. M. Howie (European Organization for Nuclear Research, Geneva).

Modifications to THRESH input, the vertex reconstruction method, and the labeling system to permit satisfactory processing of the Hough-Powell digitizer data are discussed. (D.C.W.)

5618 (CERN-63-34(p.133-9)) ATTEMPTS TO OBTAIN HIGH RATE, HIGH QUALITY MEASUREMENT OF EVENTS DESPITE FILTER II IMPERFECTIONS. P. V. C. Hough (Brookhaven National Lab., Upton, N. Y.).

The benefits derived from using CONTROLLED FILTER are discussed, and the operation and performance of a production measurement system using CONTROLLED FILTER are described. Remaining difficulties in road-fitting are also discussed. (D.C.W.)

5619 (CERN-63-34(p.141-59)) THE AUTOMATIC ANALYSIS OF SPARK CHAMBER PICTURES USING A FLYING SPOT DIGITISER. P. M. Blackall, G. R. Macleod, and P. Zanella (European Organization for Nuclear Research, Geneva).

A computer program for automatic analysis using a flying-spot digitizer on-line with the computer is described. The program, for an IBM 709/7090, controls the digitizer and performs all the operations necessary for automatic film scanning and measurement and space reconstruction of true elastic scattering events. (D.C.W.)

5620 (CERN-63-34(p.161-9)) THE NEVIS SPARK CHAMBER AUTOMATIC MEASURING MACHINE (SAMM). M. Arm, D. Brown, A. Jacobson (Columbia Univ., New York. Electronics Research Labs.), S. Adler, and D. H. Tycko (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.).

A flying-spot digitizer system for automatic analysis of spark chamber photographs is described. The performance and programming of the system are discussed. (D.C.W.)

5621 (CERN-63-34(p.171-83)) A SPARK CHAMBER FILM READING SYSTEM. W. F. Baker (Brookhaven National Lab., Upton, N. Y.).

A system that digitizes the coordinates of all the information on the film and records it on magnetic tape for processing in an IBM 7094, where sparks and tracks are reconstructed and the events are kinematically analyzed, is described. The flying spot scanner, the data processing unit, and the computer programs are discussed. (D.C.W.)

5622 (CERN-63-34(p.185-9)) SASS. D. Hall (California. Univ., Berkeley. Lawrence Radiation Lab.).

Current plans for the Spark Chamber Automatic Scanning System for film reading and data reduction are given. (D.C.W.)

5623 (CERN-63-34(p.191-200)) A MATHEMATICIAN LOOKS AT BUBBLE AND SPARK CHAMBER DATA PROCESSING. J. W. Calkin (Brookhaven National Lab., Upton, N. Y.).

The merits of specific embodiments of flying spot digitizer and scanning-measuring projector systems for recording and processing bubble chamber data are discussed, along with the form of the associated computer programs. (D.C.W.)

5624 (CERN-63-34(p.203-8)) PEPR-PROGRAMMING PROGRESS. W. Humphrey (California. Univ., Berkeley. Lawrence Radiation Lab.).

The properties of PEPR hardware that are relevant to the programming are described, and the proposed program structure is outlined. Programming problems, particularly the track matching problem, are briefly discussed. (D.C.W.)

5625 (CERN-63-34(p.215-21)) COMPUTER ASSOCIATION OF TRACKS IN DIFFERENT VIEWS. D. Burd (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.) and P. L. Connolly (Brookhaven National Lab., Upton, N. Y.)

A method for association of tracks in different views on the basis of the angle at the vertex and the overall curvature of the track is described, along with the operation and performance of a prototype computer program. (D.C.W.)

5626 (CERN-63-34(p.243-54)) CURRENT STATUS OF THE DIGITAL PATTERN RECOGNITION PROGRAM AT BNL. G. Rabinowitz (Brookhaven National Lab., Upton, N. Y.).

The track reconstruction program that reduces digitizations entering the computer to information on track segments is described and demonstrated. (D.C.W.)

5627 (CERN-63-34(p.259-63)) LUCIOLE. H. Anders, T. Lingjaerde, J. A. Wilson, and D. Wiskott (European Organization for Nuclear Research, Geneva).

An on-line scanning system for the analysis of spark chamber photographs is described. A high-resolution cathode ray tube produces a continuously running TV-like scan with a film spot size not exceeding 30 μm diameter over 36 × 36 mm. The flying spot generator, the digitizing process, and the programming are discussed. (D.C.W.)

5628 (IDO-16923) ROUTINE TESTING AND CALIBRATION PROCEDURES FOR MULTICHANNEL PULSE ANALYZERS AND GAMMA-RAY SPECTROMETERS. D. F. Crouch and R. L. Heath (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Nov. 1, 1963. Contract AT(10-1)-205. 30p.

Procedures for the routine calibration of gamma-ray scintillation spectrometers and multichannel pulse-height analyzers are presented. A scintillation spectrometer, designed for use of recently developed computer data processing techniques, is described. The performance specifications required of all electronic components in this application, particularly the performance specifications for multi-channel pulse-height analyzers, are treated; and simple tests are described for determining the performance specifications of an analyzer. (auth)

5629 (JINR-P-1416) KHARAKTERISTIKI MNOGOSLOINOI ISKROVOI KAMERYU S RAZLICHNYM GAZOVYM NAPOLNENIEM. (Characteristics of Multiplate Spark Chamber with Different Gas Filling). I. I. Gromova, F. Legar, V. I. Nikanorov, H. Peter, and A. F. Pisarev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 19p.

Results of investigating the parameters of multiplate spark chambers when filled with different gases are presented. The dependence of the detection efficiency of charged particles on the magnitude of the purifying field, pulse delay, pressure, and kind of gas was studied. The effect of the purifying field amplitude on the memory time was also investigated. (auth)

5630 (JINR-P-1433) EFFEKTIVNOST' REGISTRATSII AKTOV DELENIYA YADER S POMOSHEH'YU STEKLA I SLYUDY. (Efficiency of Detecting Fission Fragments by Glasses and Mica). A. Kapustsik, V. P. Perelygin, and S. P. Tret'akova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions).

The efficiency of detecting fission fragments with the help of photoglass, phosphate glass, and synthetic mica was measured. It was found to be (42 ± 4)%, (67 ± 5)%, and (83 ± 5)%, respectively. In the case of photoglass the threshold for detecting the fission fragments was determined to be about 15 to 20 Mev.

5631 (NP-13382) HUMAN INTERNAL RADIOISOTOPE DOSIMETRY. INSTRUMENTATION, PROPHYLAXIS AND THERAPY. Progress Report, September 1, 1958–June 30, 1960. George R. Meneely (Vanderbilt Univ., Nashville. School of Medicine). Contract MRDC-DA-007-MD-995. 141p.

The design and calibration of a low-level γ radiation whole-body counting facility is described. The instrument is a prototype field unit for use by the military in rapid scanning of large numbers of individuals. Applications are reported of the instrument in studies of the absorption and distribution of inhaled $S^{35}O_2$ in dogs, the physiological behavior of Cs^{137} in relation to that of K in rats and other laboratory animals, and measurements of naturally occurring K^{40} and Cs^{137} from fallout in man. Results are included from a survey of residents of Davidson County, Tennessee, on attitudes toward nuclear radiation. (C.H.)

5632 (ORNL-3499(Vol.I)(p.181-7)) A SHIELDED-DIODE FAST-NEUTRON SPECTROMETER. V. V. Verbinski, M. S. Bokhari, and H. A. Todd (Oak Ridge National Lab., Tenn.).

A spectrometer for measuring reactor fast-neutron spectra amid intense gamma-ray and fast neutron fields was developed. It consists of an independently supported Li^6F layer between two separated silicon surface-barrier diodes. Neutrons are detected by observing coincidences between the alpha particles and the tritons produced in the $Li^6(n,\alpha)T$ reaction, for which the Q value is 4.78 Mev. Substitution of an Li^7F layer for the Li^6F layer permits the measurement of the background from (n, charged-particle) reactions in silicon with good accuracy. The response of the spectrometer is linear over the neutron energy range from 0 to 14.7 Mev. The detection efficiency

was measured to be about 3.5×10^{-3} for thermal neutrons and was estimated to be 5.2×10^{-7} for 3-Mev neutrons. (auth)

5633 (ORNL-3499(Vol.I)(p.188-90)) A METHOD OF CORRECTING GAMMA-RAY SPECTRAL MEASUREMENTS FOR COLLIMATOR EFFECTS. G. T. Chapman (Oak Ridge National Lab., Tenn.).

A method of approximately calculating the effective increase in the illuminated area of a gamma detector due to gamma penetrations through small thicknesses of material at the entrance and exit apertures of the gamma collimator was developed. Excellent agreement with experimental observations using a small Cs^{137} source was obtained. (auth)

5634 (ORNL-3499(Vol.I)(p.190-3)) SOME FORTRAN CODES USED IN THE INITIAL REDUCTION OF DATA TAKEN WITH MULTICHANNEL PULSE-HEIGHT ANALYZERS. J. D. Jarrard and G. T. Chapman (Oak Ridge National Lab., Tenn.).

Three programs written for the IBM-7090 computer and used in the reduction of data taken with multichannel pulse-height analyzers are described. The programs are: PREPARE, which generates the first estimates of a set of Gaussian parameters for use in a nonlinear least-squares fit; BIFIT, which performs a polynomial least-squares fit considering uncertainties in both the x and y coordinates; and ADJUST, which numerically corrects a measured pulse-height distribution for a gain and/or zero shift of the electronic measuring system. (auth)

5635 (ORNL-3499(Vol.I)(p.194-6)) TEMPERATURE COEFFICIENT OF HURST-TYPE FAST-NEUTRON DOSIMETERS. R. E. Wright (Oak Ridge National Lab., Tenn.).

In an experiment performed to determine the effects of temperature on a Hurst-type fast-neutron dosimeter, it was found that the dosimeter can be used over the temperature range of −80 to 100°F with a reasonable sensitivity change (4.5%). Between 100 and 150°F a change of 0.22% per °F can be expected. The transistor preamplifier used exhibited a compensating gain change when used in the same environment, so that the effective upper end of the operating range could be extended to 120°F. (auth)

5636 (PAN-270) SOME EXPERIENCE IN THE WORK WITH THE NEUTRON CRYSTAL SPECTROMETER. Z. Dimitrijević, Sz. Kraśnicki, R. Maglić, V. Marković, and J. Todorović (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). July 1963. 29p.

The procedures followed in installing and adjusting the triple-table spectrometer are described, along with an investigation of single crystals for use as monochromators and analyzers of thermal neutron energy. With Al monocrystals nonmonotonic intensity distribution within the reflected beam was clearly observed, due to lineage structure. A Ge (111) monocrystal was used to measure the thermal neutron spectrum from a horizontal beam hole of the TVRS reactor in Vinca. (D.C.W.)

5637 (PAN-444/Ia,II IX) RECENT RESULTS ON SILICON SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. J. Chwaszczewska, M. Dakowski, W. Przyborski, M. Sowinski, A. Szechter, E. Kierzek-Pecolt, Z. Weydman, and E. Zalewski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 33p.

Some investigations on the production, performance, and improvement of n-p silicon detectors are described, along with circuitry designed for use with such detectors. Surface barrier detectors, junction detectors with P diffused into p-type Si, Li-drifted detectors, and Ga-diffused B–Si detectors were considered. (D.C.W.)

5638 (RISÖ-68) MAGNETIZATION PROCEDURE FOR LOW FIELD SETTINGS OF A SIX-GAP IRON BETA-RAY SPECTROMETER. P. Gregers Hansen, H. Loft Nielsen, and Kai Wilsky (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Oct. 1963. 14p.

The focusing properties of the Risö orange spectrometer were investigated through field measurements and the study of electron line shapes. Even after a careful demagnetization procedure, unsatisfactory field distributions were obtained at low energies in the wedge-shaped gaps. This effect can be eliminated if the demagnetization is followed by suitable premagnetization steps. (auth)

5639 (SC-TM-332-63(33)) CONVERSION OF A SINGLE-CHANNEL PULSE HEIGHT ANALYZER TO A 100 STEP/CHANNEL RADIATION ANALYZER. R. E. Womelsduff and D. J. Coleman (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract [AT(29-1)-789]. 30p.

A method is presented for converting a commercial single-channel pulse-height analyzer to a quasi-multichannel analyzer which provides greater flexibility in gamma energy range and in counting time at any given gamma energy. (auth)

5640 (TID-7673(p.3-24)) THE SCANNING SYSTEM AND ITS PARTS. William J. MacIntyre and James H. Christie (Western Reserve Univ., Cleveland).

Applications of radioisotope scanning techniques in radiodiagnosis are reviewed. Recent improvements in scanning systems and components are described. Emphasis is placed on the development of crystal-shield collimator combinations, pulse-height analyzers, data presentation representative of the entire organ that distinguishes between variations in counting rate due to random fluctuation or to variations in isotope distribution, and methods for the integration of scanning information. Photographs are included of illustrative scans. (C.H.)

5641 (TID-7673(p.25-65)) COLLIMATORS FOR RADIOISOTOPE SCANNING. C. Craig Harris, P. R. Bell, J. E. Francis, Jr., M. M. Satterfield, J. C. Jordan, and J. P. Murray, Jr. (Oak Ridge National Lab., Tenn.).

Developments in the design of collimators to confine the field of vision of a γ-ray scintillation detector to a small volume in a patient's body during radioisotope scanning are reviewed. It is pointed out that, though progress has been made, collimators have not yet reached the high standards of performance required for the maximum use of scanning as a diagnostic aid. (C.H.)

5642 (TID-7673(p.236-49)) HIGH-ENERGY GAMMA-RAY SCANNER. Peter J. Kenny, J. S. Laughlin, D. A. Weber, K. R. Corey, and E. Greenberg (Sloan-Kettering Inst. for Cancer Research, New York).

A high-energy γ-ray scanner is described that was designed for whole-body scanning. Two identical scanning heads were used, one to move above the patient on an elevated track and the other to move below the patient on a floor-mounted track. The movements of the detectors are controlled by electric motors, that may be programmed to drive the detectors, or the detectors may be operated manually, Spectrometer, readout, and control circuits were incorporated. Applications of the scanning system in the measurement of tracer doses of γ-emitting radioisotopes in patients are reported. Data are given on the distribution and excretion of injected I^{131}, Sr^{85}, and Ca^{47} in patients. The method is compared with results obtained by the measurement of radioactivity with excreta. (C.H.)

5643 (UCRL-7488) A ROD-CONDUCTION RADIOMETRIC CALORIMETER. Stuart R. Gunn (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 11, 1963. Contract W-7405-eng-48. 11p.

A twin rod-conduction calorimeter for routine assay of small radioactive sources is described. The equilibration time is about forty minutes and the detection limit about 1×10^{-4} watt. A thermistor circuit and nonlinear potentiometer are used for the differential temperature measurement. Use of a plutonium sample for calibration is described. (auth)

5644 PROPERTIES OF GEIGER-MUELLER COUNTER WITH GLASS AND GRAPHITE WALLS CONTAINING AMMONIA VAPOR. Robert Saporte. Ann. Fac. Sci. Univ. Toulouse Sci. Math. Sci. Phys., 25 (1961): 97-110(1963). (In French)

Ammonia fillings, previously tested in classical detectors with metallic cathodes, were introduced into glass cylinder counters. The plateau and background characteristics, before aging, are analogous to those of counters with metallic walls. Under constant irradiation, the mean current crossing the detector is a linear function of the applied voltage; the slope is independent of the ammonia pressure between 2 and 10 cm Hg. This slope varies only very little with the counter geometry (wire diameter, cathode diameter, and cathode length). Analogous results were obtained on sulfuric acid fillings. A previously reported method was used to measure the mobility of the ammonia ions in the discharge. Its value is 0.90 $cm^2\ sec^{-1}v^{-1}$, at atmospheric pressure. The progressive deterioration of the detector as a function of the number of pulses was the object of a detailed study because the ammonia fillings owe their interest to their long lifetime. The variation of the concentration of ammonia in the gaseous mixture was determined as a function of the number of pulses. No compound of the form N_xH_y was formed, and the only decomposition products were nitrogen and hydrogen. Contrary to the counters with metallic walls, the equilibrium between the ammonia, nitrogen, and hydrogen is attained only after 3×10^9 to 4×10^{10} pulses and always after the counting plateau has disappeared. This fact can be explained by the initial elimination, on the wire and the internal wall of the glass cylinder, of the nitrogen and hydrogen contained in the gaseous mixture. (tr-auth)

5645 PLAN FOR THE CONSTRUCTION OF A TOTAL-BODY RADIOACTIVITY COUNTER USING GAMMA SPECTROMETRY. P. Delwaide, C. Heusghem, W. G. Verly, J. Colard, and R. Boulenger. Arch. Belges Med. Sociale, Hyg., Med. Travail Med. Legale, 20: 293-312(May 1962). (In French)

A survey of the importance of total-body radioactivity counters for medicine is presented together with a plan for the construction of such an apparatus at the Université de Liège. Measurements are made by use of gamma spectrometry, which permits qualitative scanning at the same time as a quantitative determination of many radioisotopes. A plastic scintillator made from plastifluor blocks surrounding the patient was adopted. The detector is a cylinder of 50-cm dia. and 1.60- to 1.80-m length. The shield surrounds the counting chamber and is usually completely closed. The shield is made of laminated steel plates, 15 to 20 cm in thickness. The electronic systems consist of one or more photomultipliers and an impulse selector. The counters will have three main applications: determination of total K in vivo, control of either natural or accidental radioactive contamination, and investigation of tracers used in very small doses. This apparatus does not offer full discrimination between various isotopes, but it satisfies many analytical clinical needs. (BBB)

5646 NUCLEAR RADIATION AND ITS MEASUREMENT. Kurt Bartneck (Telefunken AG, Ulm, Ger.). At. Strom, 9: 77-84(Oct. 1963). (In German)

After a review of the utilization of the vast thermal energies produced by nuclear power reactors for the electrical industry and other applications, the various types of radiation and their effects are described. The measurement devices necessary for work with radiation and their operation are discussed. (tr-auth)

5647 CALIBRATION OF γ DETECTORS FOR ATMOSPHERE MONITORING IN $\mu C/cm^3$ BY MEANS OF A POINT RADIATION SOURCE. W. M. Pusch (Philips GmbH, Vienna). Atomkernenergie, 8: 410-14(Nov. 1963). (In German)

In the surroundings of a reactor plant, the specific concentration of the activity in the atmosphere has to be surveyed. The approximation of this natural or artificial activity is possible when every counting tube (ionization chamber) is sufficiently sensible. But there is the problem of calibrating these detectors, which means the determination of the connection between the contamination of the air (measured in $\mu C/cm^3$) and the expected counting rate (ionization current), which cannot be effected directly. A possible method for calibration of such tubes is described. The calculated flux, which is caused by a contamination of the atmosphere in the point of interest, is equalized with the flux being caused by a standard point source, having the same energy as the γ emitter in the atmosphere. This equation delivers the certain amount of specific activity concentration, for which the flux and the counting rate would be the same as for the point source. The counting rate of the point source, however, can be easily measured. So the counting rate to be expected for a certain activity is determined and furthermore, because of the proportionality of specific concentration and counting rate, for any other contamination, too. Absorption and scattering in the atmosphere were considered in this calculation, and also, in a simplified matter, the dependence of the detector sensitivity from the direction of the incident beam. (auth)

5648 AUTOMATION OF MEASUREMENTS OF IONIZING RADIATION. L. A. J. Venverloo and A. J. Duivenstijn (Philips' Gloeilampenfabrieken, N. V., Eindhoven, Netherlands). Atomwirtschaft, 8: 603-7(Nov. 1963). (In German)

Automatic measuring equipment including automatic specimen changing, the associated electronics, and tape printers for recording the results in digital form are discussed. It is preferable with large or very large quantities of individual specimens to use a series of measuring positions each of which is reserved for the assessment of a typical kind of preparation. It is then expedient to use the equipment required for processing of digital data as a common equipment covering all the different measurements. Apparatus is described for combining the measuring arrangements which satisfy these requirements. It is based on standard equipment for the measurement of ionizing radiations. The treatment is essentially in terms of an integrated system with a maximum of ten measuring points and of integrated systems with up to 100 points. Measuring positions are described for the determination of half life times. All modules which constitute the apparatus contain a so-called logical element. They can be stopped and started with the help of electrical signals (impulses) or the course of the measurement can be restored. (auth)

5649 CORRECTION OF DISTORTIONS DUE TO THE RESOLVING POWER OF SCINTILLATION COUNTERS.

Gilbert Vedrenne, Daniel Blanc, and Francis Cambou (Faculté des Sciences, Toulouse). Compt. Rend., 257: 3358-61(Nov. 25, 1963). (In French)

A method is described for correcting the distortions produced by the resolving power of the apparatus, in spectra measured by scintillation counters. This correction, applied to the distributions of recoil deuterons produced by 14.1-Mev neutrons in a deuterated benzene scintillator, permits the determination of the n-d differential scattering cross section for neutrons of constant energy. (tr-auth)

5650 SLOW-FAST COINCIDENCE SYSTEM FOR A FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. P. Horváth, J. Juna, and K. Konečný (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 13: 754-64(1963).

The arrangement of a slow-fast coincidence system for a fast neutron time-of-flight spectrometer is described. In the fast section of the instrument a fast differential coincidence circuit is used. Compared with the original arrangement the circuit permits a higher system stability to be achieved. Results are given of measurements on neutrons from the $Li^7(d,n)Be^8$ reaction. (auth)

5651 MEASURING OF HIGH X-RAY DOSES BY OPTICAL ABSORPTION IN GLASS OR PLASTICS. E.-G. Hofmann (Allgemeine Elektricitäts-Gesellschaft, Berlin). Kerntechnik, 5: 439-45(Nov. 1963). (In German)

For irradiation purposes in research and industry high-power x-ray equipment is available. In the various applications doses ranging from 10^4 to 10^8 rad are required. A simple and inexpensive method for measuring doses is offered by the resulting discoloration of glass or plastics in the ultraviolet region. Extensive studies were made with a borosilicate type glass with 0.1 mole % Co_3O_4 and with "Plexiglas" and acetate foil. When combined, these three compounds form a useful dosimetry system with individual measuring ranges overlapping each other. When arranged on a production line it permits the measurement of the irradiation dose applied to the individual product. (auth)

5652 A NEW FILM BADGE FOR MIXED RADIATION OF VARIOUS TYPES. H. Dresel (Universität, Freiburg i. B.). Kerntechnik, 5: 446-9(Nov. 1963). (In German)

An opinion is given on the problems of the number, arrangement, and the appropriate size of filters used in film badges for mixed radiation of various types in determining personal doses. The respective filter size depends on the importance of the filter for the reliability of the dose to be calculated. The decrease of trace detectability in the case of nuclear films (determination of the dose of fast neutrons) due to storage conditions is considered. A badge is presented that offers considerable advantages as compared to other badges used. (auth)

5653 ABSOLUTE MEASUREMENTS ON RADIOACTIVE SUBSTANCES. PART I. MEASUREMENTS WITH THE AID OF THE 4π PROPORTIONAL COUNTER. Istvan Dezsi and Istvan Feher (Central Research Inst. for Physics, Budapest). Magy. Fiz. Folyoirat, 11: 285-94 (1963).

A 4π proportional counter, in which the specimen is inserted in the interior of the instrument, is described. The detector, the counter proper, the electronic circuit, the source receptacle, and the operation of the device is described. Various tests performed with the instrument are discussed. A series of primary standards were prepared with the aid of the device described. (OTS)

5654 THE SILICON DETECTORS OF THERMAL NEUTRONS. Janina Chwaszczewska and Andrzei Szechter (Inst. of Nuclear Research, Academy of Sciences, Warsaw). Nukleonika, 8: 489-93(1963). (In Russian)

Surface barrier detectors for charged heavy particles were used for detection of thermal neutrons by means of covering them with a layer of boron, lithium, and uranium. The acting area of the detectors range from 10 to 500 mm^2. The resistivity of silicon used for the detectors was 265 and 1000 ohmen. Efficiency and some of their characteristics were measured. (P.C.H.)

5655 MULTICHANNEL ANALYZERS WITH MAGNETIC MEMORY DEVICES (REVIEW). A. P. Tsitovich (Inst. of Atomic Energy, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 5-22(Sept.-Oct. 1963). (In Russian)

A brief review is given of the characteristics and applications of multichannel analyzers. Emphasis is placed on the memory devices in multichannel amplitude and time analyzers using magnetic tapes and cylinders. The principles of operation and the circuitry of the analyzers are discussed. (tr-auth)

5656 DOUBLE-CRYSTAL SCINTILLATION GAMMA SPECTROMETER WITH ORGANIC CRYSTALS. Ya. Urbanets and I. Kaifosh (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 5, 40-3 (Sept.-Oct. 1963). (In Russian)

The properties of a double-crystal scintillation Compton spectrometer in which the primary γ rays are back scattered in one of the crystals are discussed. The organic crystal stilbene is used. High efficiency is obtained and spurious coincidence lines are removed from the spectra. (tr-auth)

5657 CALIBRATION OF SCINTILLATION GAMMA SPECTROMETERS FOR ABSOLUTE MEASUREMENTS. A. N. Silantev. Pribory i Tekhn. Eksperim., No. 5, 44-8 (Sept.-Oct. 1963). (In Russian)

A method for calibrating a scintillation gamma spectrometer by means of 4π β-γ coincidences is described and a formula for processing the results is derived. An analytical expression is derived for the efficiency of the spectrometer as a function of gamma energy. A graph is presented for the efficiency of the spectrometer with sodium iodide crystals. The absolute efficiency of the spectrometer is obtained. (C.E.S.)

5658 CONTROL SYSTEM FOR REGISTERING NUCLEAR REACTIONS AT 100 Bev. K. A. Kotelnikov and O. F. Ogurtsov (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 51-3(Sept.-Oct. 1963). (In Russian)

A system is presented for increasing the efficiency of ionization calorimeters used for detecting cosmic shower particles in the energy range of 100-1000 Bev. (C.E.S.)

5659 APPARATUS FOR AUTOMATIC MEASUREMENT OF THE COORDINATES OF TRACKS OF CHARGED PARTICLES FROM BUBBLE CHAMBER PHOTOGRAPHS. Yu. A. Karzhavin, I. V. Chuvilo, S. S. Kirilov, et al. (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 5, 54-60(Sept.-Oct. 1963). (In Russian)

An apparatus for the automatic measurement of the coordinates of particle tracks on photographs obtained from bubble, diffusion, and other chambers is presented. The measured coordinates are registered on perforated tape for insertion into a calculating machine. The maximum traveling speed for the tracks in the automatic system is

3 mm/sec. The precision of the coordinate readings is 2.5 μ and the mean-square deviation is 2.5-4.0 μ. It is possible to operate the apparatus manually for precise measurement of the coordinates of separate points. (tr-auth)

5660 PULSE AMPLITUDE DISTRIBUTIONS IN SLOW NEUTRON DETECTORS. V. Ya. Savelev, A. I. Beskorskii, and V. I. Chernyshov. Pribory i Tekhn. Eksperim., No. 5, 61-5(Sept.-Oct. 1963). (In Russian)

A function for the pulse amplitude distributions in slow neutron detectors containing BF_3 was determined for different gas pressures and detector diameters. The function takes into account the presence of wall effects and the sticking of electrons. Experimental histograms of pulse amplitude distributions were presented. (tr-auth)

5661 WIDE-RANGE ROENTGENOMETER. V. P. Ivanov, K. F. Minin, and A. M. Kuzin. Pribory i Tekhn. Eksperim., No. 5, 65-9(Sept.-Oct. 1963). (In Russian)

A roentgenometer for measuring doses of γ radiation in the range 10 μr/hr to 10^4 r/hr is described. The detector apparatus contains the counters STS-5 and SI-3BG. The method for broadening the range of the roentgenometer is explained. The method for determining the voltage characteristics of the detector is outlined. (tr-auth)

5662 SCINTILLATION COUNTER FOR HEAVY IONS. L. I. Pivovar, L. I. Nikolaichuk, and A. I. Vlasenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekhn. Eksperim., No. 5, 70-2(Sept.-Oct. 1963). (In Russian)

A scintillation counter was adapted for detection of relatively slow heavy ions. Experiments with Li^+, Na^+, and K^+ ions were described. It is shown that the scintillation counter can detect ions in the energy range of several tens of kev. (tr-auth)

5663 DEVICE FOR DETERMINATION OF SMALL AMOUNTS OF RADIOELEMENTS BY THE METHOD OF SEPARATION OF α-γ COINCIDENCES. V. F. Mikhailov (Inst. of Geology, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 75-7(Sept.-Oct. 1963). (In Russian)

An apparatus is described that permits the measurement of the energy of α particles from disintegrating nuclei by the separation of γ-α coincidences with subsequent pulse amplitude analysis. The device can determine the intensity of α particles from weak odd emitters in the background of the predominate lines of even nuclei. (tr-auth)

5664 STATIC MEMORY DEVICE FOR AMPLITUDE ANALYZERS WITH RECORDING OF INFORMATION ON MAGNETIC SURFACES. A. P. Tsitovich and Yu. I. Zaitsev (Inst. of Atomic Energy, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 82-9(Sept.-Oct. 1963). (In Russian)

A static memory device for a 100-channel amplitude analyzer designed for continuous measurements is described. The recording of information is controlled by double heads on either a magnetic cylinder or on a flexible magnetic disk. (tr-auth)

5665 RECORDING TIME-TO-PULSE HEIGHT ANALYZER WITHOUT PRELIMINARY STORAGE OF INFORMATION. M. S. Birulev, I. Lang, A. F. Linev, A. M. Sukhov, and L. P. Chelnokov (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 5, 90-7 (Sept.-Oct. 1963). (In Russian)

An analyzer system is described that simultaneously registers the numerical conversions in detectors relative to the time of the appearance of the pulse and its amplitude. Measurements are recorded on telegraphic tape at a speed not exceeding one measurement per second. The analyzer is intended mainly for the registration of rare events when the total number of registered pulses is not large. (tr-auth)

5666 REDUCTION OF BACKGROUND OF RANDOM COINCIDENCES BY SEPARATION OF A SERIES OF PULSES. V. G. Fleisher (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 112-13(Sept.-Oct. 1963). (In Russian)

An auxiliary system for the separation of a series of pulses to reduce the background of random coincidences is applied to a time-to-pulse-height converter for preservation of the efficiency and time resolution for coincidences. The system is essentially for work with large time resolution or large charging when the number of random coincidences are comparable to the actual coincidences or when there is a large number of actual coincidences. A schematic diagram and experimental results are presented for the converter operating in the microsecond region. (tr-auth)

5667 THE DEAD TIME OF A G.M. COUNTER TUBE. G. A. Brinkman (Inst. for Nuclear Physics Research, Amsterdam). Radiochim. Acta, 2: 41-6(Oct. 1963).

It is proved that the commonly used formula for dead time corrections: $N' = (N/1-N\tau)$ (N' is the true and N the measured count rate, τ the dead time) is correct for a G-M counter tube and also for high count-rates. However τ seem to be a function of N. Three often used methods for measuring the dead time τ are discussed (the two-samples method; the method of a series of samples in which the relative intensities are very well known; the method of a shortlived radioisotope), and also for each of these three methods the best way to calculate the dead time from the experiments. The two-samples method, combined with a formula of Schulze, seems to be the most attractive solution. The theory was illustrated by a number of experiments according to the three different methods. (auth)

5668 FAST-NEUTRON DETECTOR WITH DISCRIMINATION AGAINST BACKGROUND RADIATION. R. B. Mendell and S. A. Korff (New York Univ., New York). Rev. Sci. Instr., 34: 1356-60(Dec. 1963).

A detector that measures neutrons between 1 and 10 Mev in a mixed background of charged and neutral radiation was developed for use in cosmic-ray studies. The detector consists of liquid scintillator NE213 surrounded by a thin shield of plastic phosphor NE102 for charged particle rejection. Both scintillators are viewed by a single photomultiplier, in an adaptation of the pulse-shape discrimination technique. (auth)

5669 BRIGHT FIELD PHOTOGRAPHY IN A HYDROGEN BUBBLE CHAMBER. D. R. Firth (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 34: 1393-8(Dec. 1963).

The performance of bright and dark field optics in a bubble chamber is analyzed. A modification of the usual bright field scheme is proposed, so that very high contrasts may be achieved even in liquid hydrogen. The new scheme can also be used in a single-window chamber. Results of tests of the scheme are presented to support this modification. Photography of bubbles smaller than the resolution limit is discussed; in this case a dark field scheme shows a clear advantage. (auth)

5670 NONSATURATING IONIZATION CHAMBER FOR HIGH INTENSITY EXTERNAL PROTON BEAM. C. E. Swartz, G. S. Levine, and R. L. Carmen (Brookhaven Na-

tional Lab., Upton, N. Y.). Rev. Sci. Instr., 34: 1398-9 (Dec. 1963). (BNL-7248)

A low density parallel plate ionization chamber that exhibits a linear response to high intensity pulses of 3-Bev protons is described. (auth)

5671 VELOCITY SERVO DRIVE FOR A HIGH PRECISION MÖSSBAUER SPECTROMETER. P. A. Flinn (Westinghouse Research Labs., Pittsburgh). Rev. Sci. Instr., 34: 1422-6(Dec. 1963).

A Mössbauer spectrometer utilizing a servomechanism to provide a constant velocity drive was developed. The apparatus is useful to velocities up to 1 cm/sec, and provides velocities known to one part in 10^3. The moving portion is relatively massive and can be used to move a small furnace or cryostat. (auth)

5672 BRIGHT-FIELD BUBBLE CHAMBER ILLUMINATION USING A BEADED REFLECTIVE SCREEN. Wilson M. Powell, Larry Oswald, Gary Griffin, and Frank Swartz (Univ. of California, Berkeley). Rev. Sci. Instr., 34: 1426-9(Dec. 1963). (UCRL-10861)

Bright-field illumination using a beaded reflective screen is accomplished in the 30-in. heavy-liquid bubble chamber by using separate light sources for each lens. The resolution obtainable is about four times as great as with dark-field illumination. (auth)

5673 COMPARATIVE DOSE MEASUREMENTS OF SCATTERED RADIATION AND THEIR DEPENDENCE ON THE INCIDENCE DIRECTION. Karlheinz Renner. Roentgen Bl., 16: 337-44(Nov. 1963). (In German)

The directional dependence of ionization chamber and counter tube instruments compared with scattered radiation is examined. Only by changing the orientation of a measuring instrument did methodic measuring errors up to 75% result. The directional dependence of instruments used for measuring scattered radiation should be taken into account in their calibration. (auth)

5674 DEPENDENCE OF WINDOW EFFECTS UPON BIAS VOLTAGE IN DIFFUSED p-n JUNCTION RADIATION DETECTORS. Hisanobu Kobayashi and Satoshi Konno. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 144-9 (Sept. 1963).

In diffused p-n junction silicon radiation detectors, variations of window thickness as a function of bias voltage were computated. Calculations were made for some models whose diffusant distributions were represented by step function, linear-step function, exponential function, and complementary error function. It became evident that the assumptions of step function and linear-step function were inappropriate for the simplified diffusant distribution considering the window thickness, because variations of window thickness with bias voltage in the cases of step function and linear-step function were 10^{-1} to 10^{-4} times as small as those in the cases of exponential function and complementary error function. It was therefore concluded that distributions expressed by exponential function and complementary error function should be applied in the computation of window thickness. The dependence of window thickness upon bias voltage was found to be important in lower bias voltage, but was negligible in higher voltage usually applied in the cases of exponential function and complementary error function. (auth)

5675 ON THE SUITABILITY OF RADIATION-PROTECTION MEASURING APPARATUS IN THE REGION OF MEDICALLY USED RADIATION ENERGIES. Dietrich Frost and Rolf A. Krause (Rudolf-Virchow-Krankenhauses, Berlin). Strahlentherapie, 122: 397-407(Nov. 1963). (In German)

Six commonly used instruments for radiation-protection measurements were evaluated. Each of these devices represents a special kind of instrument. The energy dependency of their responses to x radiation, gamma radiation, and betatron radiation is reported. In addition, the angular dependency of the response is investigated. The possible situations using each instrument are reported. (auth)

5676 THE SENSITIVITY OF ILFORD Q1 PLATES FOR IONS AT 25 kev ENERGY. Erich Burlefinger and Heinz Ewald (Technische Hochschule, Munich). Z. Naturforsch., 18a: 1116-21(Oct. 1963). (In German)

The yields of blackened grains in the bombardment of Ilford-Q1 plates with H^+, H_2^+, D_2^+, and Ar^+ ions of various energies were determined. The results of this and previous investigations were in harmony with theoretical expectations concerning the range of these ions in the photographic emulsion assumed to have single-grain layers. (tr-auth)

5677 PHOTOMICROGRAPHY OF ELEMENTARY CHARGED PARTICLE TRACKS IN NUCLEAR EMULSIONS. L. von Lindern (Max-Planck-Institut für Physik und Astrophysik, Munich). Z. Wiss. Mikroskopie, 65: 113-17(Dec. 1961). (In German)

An automatic synchronous motor-driven focal plane shutter with a speed of 3 mm/5 sec is utilized with a slit width of 3 mm to facilitate detection of elementary charged particles that impinge onto nuclear emulsions at acute angles. The aperture shield serves as a projection control directly before and behind the slit. The slit shutter may be rotated or displaced on the projection screen. The shutter permits the exposure of only that range of the image that is covered by the depth of field at any time. By means of continuously refocussing the microscope very steep tracks can be recorded as a whole within the field of view. This equipment uses 35 mm film and it has successfully recorded since 1953 about 300 tracks of events produced by various types of charged particles. (BBB)

5678 TIME OF FLIGHT SPECTROMETER CIRCUITS [Q-2558] (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1037)

This package contains circuit drawings that describe a time-of-flight spectrometer, Q-2557. The spectrometer is used in cross section studies with the 3-Mev Van de Graaff accelerator. (F.S.)

5679 ALPHA PROBE (Engineering Materials). (California. Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-558)

This package contains 7 drawings. The probe is used to guard against alpha contamination in a laboratory. Modified versions of the probe are used in alpha hand and shoe counters, floor monitors, and air filter monitors. It is an air proportional-type probe with 20 $in.^2$ of active area. It is insensitive to beta and gamma radiation and has a low fast-neutron response (0.003%). Operating voltage at sea level is 1750 v with breakdown occurring at 1810 v or higher. Backgrounds are typically 2 c/m and the efficiency for 5-Mev alpha particles is 16%. (F.S.)

5680 IMPROVEMENTS IN OR RELATING TO A MINIATURE NEUTRON-FISSION IONIZATION CHAMBER. Marcel Guery (to Commissariat à l'Energie Atomique). British Patent 938,594. Oct. 2, 1963. Priority date Jan. 7, 1960, France.

A process is described for manufacturing a neutron-

fission ionization chamber working in pulses and having an internal and an external electrode. The transverse measurement of the external electrode is of the order of 5 mm or less. Fissile material is deposited on the internal electrode. An insulator is welded in fluid-tight manner between one end of the external electrode and the lead-out of the internal electrode with the fissile material remote from the weld. The chamber is evacuated, cleaned, and filled with a filling gas. The other end of the external electrode is closed in a fluid-tight manner. The electrodes and all other metal pieces are made of dehafniated Zr or Zr alloy. The insulator is of glass capable of being welded to Zr or Zr alloy and free from materials of high neutron absorption. The filling gas is a rare inert gas at a pressure of 3 to 30 atm, and the space between the electrodes may vary from 2 to 0.2 mm. The device is suitable for use under conditions of temperature and corrosion encountered in reactors but unsuitable for use in weak flows. (A.G.W.)

5681 DOSIMETER OF THE RADIO PHOTOLUMINESCENT GLASS TYPE. Benjamin Shenker and Burton P. Fabricand (to Industrial Electronic Hardware Corp.). U. S. Patent 3,100,262. Aug. 6, 1963. Filed July 19, 1961.

Improvements to a personnel dosimeter of the type usually worn about the neck are proposed. The detecting element is a square parallelepiped of radio-photoluminescent glass approximately $\frac{3}{4} \times \frac{3}{4} \times 0.18$ in. It is housed in a two-part, generally cylindrical case, closed by a cover and sealed by a gasket. A water-tight seal is obtainable with a gasket of irradiated polyethylene used in conjunction with a half-round bead. Special holes in the cover are provided to receive special tools for applying the high torque needed for sealing. The device is thereby made almost tamper-proof. The outer case is so designed as to provide substantially uniform response regardless of directivity of the incident radiation and of the energy of the radiation within the limits of 80 kev and 1.3 Mev. (A.G.W.)

5682 RADIATION DOSAGE LIMITER. George B. Foster (to Industrial Nucleonics Corp.). U. S. Patent 3,100,843. Aug. 13, 1963. Filed Nov. 23, 1959.

Instrumentation is described by means of which a user of a radiation device may avoid subjecting the material under observation to a total radiation dosage greater than a given limit. Means are provided for measuring the rate of material movement through the radiation field, computing the integrated dosage received by the material, comparing the computed dosage with a previously established excessive value, and substantially reducing the intensity of the radiation field when the computed dosage exceeds the excessive value. The intensity of the radiation field is reduced by a shutter adapted for rectilinear movement from a position outside the radiation field to a position inside it. An alarm may also be sounded to inform the process operator of the shutter closure. The device may be so arranged as to provide for diverting the material from the radiation field when the excessive dosage value is exceeded. (A.G.W.)

5683 IONIZING RADIATION DETECTOR OF THE SCINTILLATION PHOTOCONDUCTIVE TYPE. John W. Taylor (to Secretary of the Navy). U. S. Patent 3,101,408. Aug. 20, 1963. Filed Jan. 18, 1961.

A direct-reading device responsive to ionizing radiation and adaptable to either personnel or area monitoring is described. The device consists of the following: a normally nonconductive detecting head having scintillation, photoconductive, and electroluminescent materials disposed between a pair of conducting plates; an alternating current supply; an indicator responsive to current flow; a quencher adapted to stop current flow therethrough at a predetermined value; electrical conductors connecting these components in series to form a closed circuit. A current flows through the circuit when the detecting head is exposed to ionizing radiation. The device is highly sensitive, light and compact, and insensitive to strong magnetic and radiofrequency fields. (A.G.W.)

5684 THERMIONIC RADIATION COUNTER. Stanley L. Ruby and Ted Fahrner (to Westinghouse Electric Corp.). U. S. Patent 3,101,410. Aug. 20, 1963. Filed Aug. 20, 1958.

Several forms of a thermionic neutron detector are described. In general an anode and a thermionic cathode are enclosed within a hollow housing. Adjacent to or incorporated in the cathode is a quantity of neutron-reactive material such as a fissionable isotope or an α-emitting isotope. The radiation responsive material is thermally coupled to the cathode in such a manner that, when the detector is exposed to neutrons, the cathode is heated and thermionically emits electrons. In one arrangement the detector operates as a switching means when the neutronic density reaches a predetermined level dependent upon the structure and materials of the detector. (A.G.W.)

5685 RADIATION DOSIMETRY AND PLASTICS COMPOSITIONS THEREFOR. Mario A. Acitelli and Gerald E. Blair (to Bausch and Lomb Inc.). U. S. Patent 3,102,197. Aug. 27, 1963. Filed Dec. 12, 1960.

The method of radiation dosimetry described consists of subjecting a body of transparent organic plastic containing an organic dye throughout its mass to radiation and measuring the resultant change in optical density. Preparation of several suitable internally dyed plastics is described, and curves illustrate the changes in absorption coefficients of the materials produced by exposure to radiation. The materials are more nearly tissue equivalent than previous inorganic dosimeter materials; they are inexpensive to manufacture and simple to use. (A.G.W.)

5686 SENSITIVE LOW VOLTAGE PROPORTIONAL COUNTER FOR NEUTRON DETECTION CONTAINING He^3 AT SUPERATMOSPHERIC PRESSURE. Tom W. Bonner (to Socony Mobil Oil Co., Inc.). U. S. Patent 3,102,198. Aug. 27, 1963. Filed Nov. 16, 1961.

The proportional counter described has an enclosure containing He^3 at pressures preferably in the range of 2 to 20 atm absolute. An electrode extending into the enclosure in contact with the He^3 is electrically insulated and supported from the enclosure walls. A voltage source connected between the walls of the enclosure and the electrode serves to provide an electrostatic field for the collection of ionized particles produced in the confined zone of He^3 by thermal and epithermal neutrons. A Cd or B shield may be used when detection of epithermal neutrons only is desired. Efficiencies markedly higher than those of BF_3 counters are obtainable. In the application of the detector to radioactive well logging, logging speeds may be substantially increased. (A.G.W.)

5687 PENETRATING RADIATION MEASUREMENT BY IONIZATION OF A PARTICLE BEARING AEROSOL. Theodore A. Rich (to General Electric Co.). U. S. Patent 3,102,200. Aug. 27, 1963. Filed May 29, 1959.

A radiation-measuring device is described wherein an aerosol-particle-bearing gaseous sample of a known concentration is exposed to the radiation to be measured so that the aerosol particles are charged by the ionizing effect of the radiation to an extent determined by the intensity of

the radiation. The charged aerosol-particle fraction is removed by passing the sample through an electric field, and the change in aerosol-particle concentration is measured as an indication of the radiation intensity. The device is expected to be highly sensitive, easy to manufacture, and rugged in construction. (A.G.W.)

5688 SCINTILLATION DETECTOR WITH COMPENSATING REFLECTOR FOR THE CRYSTAL. Roland W. Carlson (to The Harshaw Chemical Co.). U. S. Patent 3,102,955. Sept. 3, 1963. Filed July 6, 1960.

An improved scintillation meter component is achieved by means of a crystal light reflector system, which has minimum efficiency in regions of the crystal where light output is high and maximum efficiency in regions where light output is low. This more nearly uniform response is obtained by adjusting the surface treatment of the crystal. Portions of the crystal surface are roughened and other portions are polished. The appropriate treatment for each portion is determined by mapping the pulse height response of the crystal as a function of position of a point source of monoenergetic radiation. This system of compensated light output results in a substantial reduction of the instrumental line width of the system. (A.G.W.)

5689 VARIABLE THERMAL-CONDUCTANCE VACUUM-WALLED CONTAINER FOR SCINTILLATION DETECTORS. Ralph Mcnagham and Reuben A. Bergan (to Well Surveys, Inc.). U. S. Patent 3,105,148. Sept. 24, 1963. Filed Feb. 26, 1960.

In order to vary the rate of heat transfer between the walls of a double-walled flask, a reservoir of gas is provided with means for releasing the gas into and moving the gas from the space between the walls. The reservoir is a tube of Ti, Zr, or other material that will absorb gas at one temperature and give off gas at another. A quantity of gas, preferably hydrogen, is contained in or on the tube. A filament is mounted inside the tube and connected by suitable leads to a power supply outside the flask. When current from the power supply is applied to the filament, the tube is heated sufficiently to drive gas from the tube. The gas spreads through the space between the walls and increases the rate of heat transfer so that the inner chamber of the flask may be cooled by surrounding the housing by a suitable coolant. When the desired temperature is reached in the inner chamber, the power supply to the filament and consequently the temperature of the tube are adjusted to cause absorption of the gas on the tube. Vacuum is thus restored in the space and heat transfer between the walls is restricted so that the desired temperature in the inner chamber can be maintained for long periods of time. Each heating of the reservoir also getters gases such as O_2, N_2, CO_2, and CO normally evolved from the walls of the container. The method is specifically applied to refrigerating and insulating electronic components in a subsurface well-logging instrument. (A.G.W.)

5690 METHOD AND APPARATUS FOR DETERMINING THE SPECTRUM OF AN ALPHA RADIATION SOURCE. Henry Ludwik Zaborowski (to Commissariat a l'Energie Atomique). U. S. Patent 3,114,040. Dec. 10, 1963. Priority date Aug. 7, 1958, France.

The apparatus comprises a hemispherical receptacle mounted on a photomultiplier, a reflective scintillating interior surface in the receptacle, a gas inlet duct in the receptacle for controlling the gas pressure within it, and an alpha source located in the region of the center of the receptacle. In determining the spectrum of the alpha source, the pressure in the receptacle is varied and the photomultiplier output is counted for each pressure to trace the spectrum. (D.L.C.)

5691 DETECTOR FOR RADIOACTIVE HYDROGEN. Charles Christianson, Morris Gilman, and Ralph C. Maggio. U. S. Patent 3,114,042. Dec. 10, 1963. Filed Dec. 27, 1960.

A device of the Geiger-Mueller type is designed for detecting radioactive hydrogen in the presence of other radioactive substances. The device comprises an envelope with thin (1 to 5 mil thick) Ni or Pd windows at the ends, an anode and a cathode spaced apart in the envelope, and a counting gas within the envelope. In operation, the suspect atmosphere is blown against one of the windows, whereby only the hydrogen diffuses into the envelope for counting. Means is provided for heating the windows to the desired temperatures. (D.L.C.)

5692 RADIATION MONITOR CONTAINING TWO CONCENTRIC IONIZATION CHAMBERS AND MEANS FOR INSULATING THE SEPARATE CHAMBERS. C. B. Braestrup and R. T. Mooney (to U. S. Atomic Energy Commission). U. S. Patent 3,119,036. Jan. 21, 1964.

This invention relates to a portable radiation monitor containing two concentric ionization chambers which permit the use of standard charging and reading devices. It is particularly adapted as a personnel x-ray dosimeter and to this end comprises a small thin walled, cylindrical conductor forming an inner energy dependent chamber, a small thin walled, cylindrical conductor forming an outer energy independent chamber, and polymeric insulation means which insulates said chambers from each other and holds the chambers together with exposed connections in a simple, trouble-free, and compact assembly substantially without variation in directional response. (AEC)

5693 END-WINDOW BETA-RADIATION COUNTER. G. B. Dashevskii. Russian Patent 154,621. Oct. 14, 1963. Filed Apr. 27, 1962.

An end-window beta counter with a cathode of current-conducting film is described. The use of such a cathode simplifies the process of manufacturing the counter. (OTS)

ISOTOPE TECHNOLOGY

General

5694 APPLICATION OF HAHN'S EMANATION METHOD FOR THE INVESTIGATION OF NATURAL MATERIALS WHICH ARE NOT LABELLED HOMOGENEOUSLY. (EMANATION METHOD WITH SURFACE LABELLING). G. Bouvier and K. Torkar (Technische Hochschule, Graz). Ber. Deut. Keram. Ges., 40: 355-64 (June 1963). (In German)

For the investigation of natural materials that cannot be labeled homogeneously the material is labeled in the granular form by adsorption of thorium-228 from an alcoholic solution. The sample is then pressed into a rectangular body and investigated in an automatic emanation apparatus. The emanation is determined by the usual method of comparison with barium palmitate standard and from emanation curves obtained with platinum sheets labeled on the surface, the activity of which is taken as 100% emanation for all temperatures. A description of the method of labeling, the apparatus, and the technique of measurement are given. For synthetic magnesite, dolomite, and zirconia the information obtained with homogeneously labeled samples and with others labeled only on the surface is compared. For dolomite the dependence of emanation on the surrounding temperature, temperature of calcination, surface area, maximum grain-size of MgO and CaO, changes of texture, and phase composition is determined. The investigations showed that emanation curves obtained from samples with surface labeling give as much information with regard to changes in the material under investigation as do curves from samples with homogeneous labeling. With surface labeling all the effects taking place at the surface or starting there are especially well indicated, such as, the beginning of solid state reactions, formation of molten phases, densification of textures, and phase transformations. (auth)

5695 IMPROVEMENTS IN AND RELATING TO CONTAINERS FOR RADIOACTIVE ISOTOPES. Herman Charles Pontet. British Patent 937,764. Sept. 25, 1963. Filed July 20, 1960.

The outer surface of the radioisotope container described is formed with a series of ribs or other projections extending laterally from the side walls and longitudinally beyond the end of the container through which an isotope-carrying plug or rod may be inserted. The construction and arrangement of the ribs is such that, if the container be dropped or fall accidentally, the impact will be taken up by the ribs and their extensions and damage to the container will be minimized. The ribs may be formed with apertures or slots for receiving ropes or straps for carrying the container. (A.G.W.)

Industrial Applications

5696 (NADC-EL-N6301) A GAMMA GUIDANCE SYSTEM FOR HELICOPTER FLIGHT-FORMATION CONTROL. G. E. Wilcox (Naval Air Development Center. Aeronautical Electronic and Electric Lab., Johnsville, Penna.). Mar. 26, 1963. 13p. (AD-400570)

Theoretical analyses and preliminary laboratory experiments indicate that the use of gamma radiation as the sensing signal for a formation-control system is feasible and promising. Reports on flight tests of related nuclear devices, such as proximity scorers and miss-distance indicators, verify the efficacy of gamma ranging devices in aircraft. Accordingly, a gamma range was instrumented, and various methods for determining range, azimuth, and elevation have been investigated. Three arrangements of sources, detectors, and visual presentations were found to be particularly promising, for which data have been accumulated and an analysis made of relative merits. One arrangement, the eclipse method, utilizes the difference signal between an unshielded and a shielded detector, and can provide an accuracy of ±10 percent in range and ±1 degree in azimuth and elevation. This method is capable of distinguishing between signals from craft only 10 degrees apart in azimuth and is amenable to a PPI type of presentation. The other two methods devised have some virtues but appear to offer less dependability and accuracy. (auth)

5697 (JPRS-21975(Del.)(p.10-12)) THE USE OF THE COMBINED EFFECT OF GAMMA-RADIATION AND CHLORINE FOR STERILIZATION OF WATER. G. I. Sidorenko, M. A. Pinigin, and V. T. Savenkova. Translated from Gigiena i Sanit., 28: No. 9, 97-8(Sept. 1963).

The combined use of gamma radiation and chlorine in water sterilization was studied. Sterile water samples were inoculated with B. coli and B. anthracoides. One set of samples was chlorinated, another irradiated with 25,000 r Co^{60} gamma, and a third both chlorinated and irradiated with doses equivalent to the controls. With the combined treatment, an equivalent effect was obtained with one-third the chlorine and one-tenth the radiation dose. (H.M.G.)

5698 (JPRS-21989(p.1-4)) APPLICATION OF RADIOACTIVE ISOTOPES IN COMMERCIAL FISHING. V. P. Kondrat'ev (Kondrat'yev). Translated from Rybn. Khozy., No. 5, 62-4(1961).

Conventional methods for labeling fish have proven to be inadequate. The use of radioisotopes in problems concerned with the theory of commercial fishing offers great promise. In addition to enlightenment on the interaction of the fish with the fishing gear, it is felt that radioisotopic tracers would be valuable in studying fish mortality, interaction of predator and prey, and the operational condition of fishing gear. It is stressed that human exposure hazards arising from radioisotopic tracers in fishing industry research are minimal. Phosphorus-32 and calcium-45 are the isotopes most frequently used. (H.M.G.)

5699 DENSITY MEASUREMENT WITH RADIOISOTOPES IN THE PETROLEUM INDUSTRY AND THE PETROLEUM PROCESSING INDUSTRY. Helmut Bierwolf. A E G Mitt., 53: 165-9(1963). (In German)

With the use of a radioactive density device, a measurement installation can be constructed whose advantage is the contact-free and continuous read-out of test data. It is suitable for density determination of every type of medium, regardless of whether it is in liquid, powder, granular, or solid form. The construction and operation of density measurement installations with radioactive isotopes is sketched. The accuracy obtainable and the resolution possible for various cases are shown. (tr-auth)

5700 CONTINUOUS FILLING-LEVEL MEASUREMENT WITH ISOTOPES. Werner Burbach. A E G Mitt., 53: 169-72(1963). (In German)

A continuous filling-level measurement, necessary on operational grounds, is often possible only with the help of radioisotopes. The most common of the devices existing at present and their sensitivities are explained and illustrated. The emphasis of the discussion is on filling-level measurement with moving radiation source. (tr-auth)

5701 RADIATION STERILIZATION OF PLASTICS. John W. Olander (High Voltage Engineering Corp., Burlington, Mass.). Bull. Parenteral Drug Assoc., 16: 10-16(July-Aug. 1962).

Effects of radiation in causing deterioration of plastic packaging material for radiosterilized pharmaceutical and hospital supplies are considered. Effects are examined for several popular plastics irradiated to a maximum dose of 5 Mrad. Changes in physical properties of polyethylene, Mylar, and Cellophane are examined in detail, and it is concluded that, while radiation in sufficient quantities can degrade any polymer system, sterilizing doses of 5 Mrad and less are not harmful to their mechanical qualities. The exception is that of Teflon and Nylon, which are generally unacceptable for radiation processing. (BBB)

5702 GAMMA RADIATION EFFECTS ON FRUITS AND VEGETABLES. D. K. Salunkhe (Utah State Univ., Logan). Econ. Botany, 15: 28-56(Jan.-Mar. 1961).

The literature relating to experimental studies of preservation of fruits and vegetables is reviewed; 109 references are cited. Studies covering the effects of γ-ray dose, rate, and temperature during irradiation, preirradiation chemical treatments, and packaging methods on the quality, chemical changes, and storage life are surveyed. The results show that crop variety and maturity play an important role in fruit and vegetable radiopreservation. Firmer crops or varieties were more suitable for radiation preservation than the softer ones. Cherries, pears, grapes, cabbage, and corn were more suitable than other crops studied. Immature or green products, when irradiated, did not ripen evenly. When over-matured crops were irradiated, the product became soft and prone to fungal infestation. In general, firm-ripe maturity is ideal for radiation preservation, regardless of crop and variety. The ripening processes of many crops were delayed by low doses (2 to 3×10^5 rad). This dose extended the storage life from 2–6 weeks at refrigeration temperatures. For sprout inhibition, a dose of ~1 to 2×10^4 rad is sufficient for most of the bulb, tuber, and root crops. When radiation dose effects were determined on vitamins, carbohydrates, proteins, and pigments of fruits and vegetables, in general, their degradation was noted when irradiated at high (>5×10^5-rad) doses. Radiation rates and irradiation temperatures did not show significant and consistent effects on fruits and vegetables, but it is advisable to irradiate products at fast rates to save time and at low temperatures to reduce shriveling. Selection of packaging film is an important factor since certain films disintegrate during radiation and impart their flavor to the products. However, Mylar C bags remained in excellent condition even up to two months when irradiated at 2×10^5 rad. It is concluded that the success of radiation preservation will depend upon the availability of a film that is stable during irradiation as well as permeable to CO_2, O_2, and other volatiles and, at the same time, impermeable to most microbes. (BBB)

5703 ON THE COMBINED ACTION OF HIGH-FREQUENCY ELECTROMAGNETIC FIELD AND ROENTGEN RADIATION IN INDUSTRY. Uy. A. Osipov, R. N. Volfovskaya, T. P. Asanova, E. L. Kulikovskaya, T. V. Kalyada, and A. V. Scheglova. Gigiena i Sanit., 28: No. 6, 35-9(1963).

The observation of persons who work under the combined action of high-frequency field and roentgen radiation showed a definite improvement in the health of the persons (decrease in the number of subjective disorders, fewer neurodynamic disturbances and pronounced normalization of blood picture) approximately a year after complete or partial withdrawal of one of the factors. It was concluded that a symptom complex previously described on this subject was caused by the combined action of high-frequency field and roentgen radiation. (Public Health Eng. Abstr., 43: No. 11, 1963)

5704 RADIATION AND RADIOISOTOPES APPLIED TO INSECTS OF AGRICULTURAL IMPORTANCE. Proceedings of the Symposium held in Athens, 22-26 April 1963. (International Atomic Energy Agency, Vienna). Proceedings Series. September 1963. 508p. (STI/PUB/74). $10.00; Sch 210; 60s.stg; F.fr. 40; DM 35(IAEA).

Separate abstracts were prepared for two papers presented at this symposium. Fifteen papers were previously abstracted and appeared in NSA. (C.H.)

For abstracts of individual papers see: 5119 and 5120.

5705 RADIOISOTOPE APPLICATIONS IN INDUSTRY. A Survey of Radioisotope Applications Classified by Industry or Economic Activity, with Selected References to the International Literature. (International Atomic Energy Agency, Vienna). 1963. 135p. $2.50; Sch 52,50; 15 s.stg; F.fr. 10,–; DM 8 (IAEA) (STI/PUB/70)

Eight-hundred seventy-six references are presented on industrial applications of radioisotopes. The references are classified by industrial categories. These include mining and quarrying; manufacturing, including chemical, petroleum, metal, and other industries; construction; electricity, gas, water, and sanitary services; and community services. A selected list of 49 conference proceedings is also included. (C.H.)

5706 METHOD OF CURING MAGNETIC TAPE BINDER COMPRISING BUTADIENE-ACRYLONITRILE AND PHENOLIC RESIN WITH SUBATOMIC RADIATION. James P. Tarwater and John Anthony (to International Business Machines Corp.). U. S. Patent 3,104,983. Sept. 24, 1963. Filed Aug. 26, 1959.

A method is described for curing a magnetic tape comprising a non-magnetic backing with a firmly adhering attached magnetic coating. The coating is a uniform dispersion of magnetic particles in a binder consisting of a butadiene–acrylonitrile copolymer and an uncured thermosetting resinous condensate of an aldehyde and a phenol. A continuous-process apparatus provides means for exposing five moving layers of freshly prepared magnetic tape to radiation from a 50-kv, 30-ma x-ray source for 6 min. The butadiene–acrylonitrile component is thus cured by crosslinking to the point of minimum flexibility required for the intended use. A batch-process apparatus is also described. (A.G.W.)

Separation and Production

5707 (IA-832) SEPARATION OF ISOTOPES BY ELECTROMIGRATION. Literature Review with Tabulated Comparison of Reported Experimental Results. M. Gazith and A. Roy (Israel. Atomic Energy Commission. Soreq Research Establishment, Nahal Soreq). Feb. 1963. 44p.

A survey of the literature on the separation of isotopes by electromigration in aqueous solutions and fused salts

is presented. A summary is given of several forms of the equations used for the evaluation of the elementary separation factors from experimental results. Reported separation factors for both aqueous solutions and fused salts are shown on a common graph. Details of about seventy experiments described in the literature are collected in several tables where materials, apparatus, electrical input, separation results, etc., are compared. A comprehensive bibliography is included. (auth)

5708 (JPRS-22385) PREPARATION OF RADIOACTIVE ISOTOPES IN THE FIRST HUNGARIAN EXPERIMENTAL NUCLEAR REACTOR. Istvan Kiss and Peter Groz. Translated from Energia Atomtech., 16: 407-14 (Sept. 1963). 21p. (OTS-64-21075)

The radioisotope program in Hungary is based on the production of radioisotopes with short lives, carrier-free radioisotopes, and radioisotopes which can not be obtained elsewhere. The irradiation facilities of the experimental reactor are described briefly. The reactions by which radioisotopes are produced and the target materials are discussed. The production and purification of I^{131}, Fe^{59}, P^{32}, and F^{18} are discussed. Hot-atom reactions are also considered briefly. (D.L.C.)

5709 PREPARATION OF A CARRIER-FREE F^{18} SOURCE. L. Balcarczyk and E. Lanzel (Osterreichische Studiengesellschaft fur Atomenergie, Seibersdorf, Austria). Atomkernenergie, 8: 404-5(Nov. 1963). (In German)

Utilizing the two nuclear reactions $Li^6(n,\alpha)H^3$ and $O^{16}(t,n)F^{18}$ carrier-free F^{18} sources were prepared for the beta spectrometer. The original material used was Li_2SO_4 and the activity of the sources varied up to 22 μC. (auth)

5710 THE SEPARATION OF H_2 AND D_2 BY MOVING-BED ADSORPTION: CORROBORATION OF ADSORBER DESIGN EQUATIONS. D. Basmadjian (Univ. of Ottawa). Can. J. Chem. Eng., 41: 269-72(Dec. 1963).

Experimental concentration profiles obtained in the separation of H_2-D_2 mixtures, by selective adsorption on charcoal in a moving-bed adsorber, were used to test the validity of semi-rigorous adsorber design equations based on considerations of gas film diffusion (utilizing the linear driving force concept), solid phase diffusion (utilizing Fick's law), and axial dispersion. The adsorption equilibrium data and solid phase diffusivities used in the design equations were also measured directly in separate experiments, whereas the gas film and axial diffusion values were evaluated from published data. In general, good agreement was obtained between the experimental and theoretically predicted concentration profiles, except at the lowest flow rates investigated. (auth)

5711 PRINCIPLE OF GAS-CENTRIFUGAL SEPARATION AND ITS APPLICATION FOR SEPARATION OF ISOTOPES. Huai-hsin Kan. Hua Hseuh Tung Pao, No. 10, 534-9(1961).

Basic principles are explained on the theory of gas centrifuges (GC) in its application for the separation of isotopes. Equations are given for the coefficient of separation of isotopes by thermal diffusion using an ordinary centrifuge and GC. The correlation of the separative power and separation coefficient are examined. Requirements are formulated with respect to materials and composition of certain alloys used in building GC. Methods of transfer of rotation, bearings, and compressions in the GC are briefly discussed. Characteristics are given of the performance of the GC built in the Federal Republic of Germany and economical comparison is made of the separation of U isotopes by GC and gas diffusion. (OTS)

5712 THE CARBON-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE REACTION. M. J. Rossiter, R. Nelson Smith, and James R. Ludden (Pomona Coll., Claremont, Calif.). J. Phys. Chem., 67: 2541-3(Dec. 1963).

It is found that, contrary to previously published results, the H_2-D_2 exchange reaction is not catalyzed by pure carbon surfaces in the temperature range 50 to 540°. This conclusion is based on experiments with a variety of ash-free sugar charcoals that were prepared at temperatures ranging from 600 to 1000° and which varied in hydrogen content from 0.42 to 2.5% and in oxygen content from 0.44 to 3.7%. A charcoal sample containing 0.15% Fe showed moderate catalytic activity toward H_2-D_2 exchange at 50°. It was concluded that the catalytic activity described in previous accounts was caused by impurities and not by the carbon surfaces per se. (auth)

5713 INSTALLATIONS FOR THE PRODUCTION OF RADIOISOTOPES. H. Huegli, J. Peter, and P. Tempus. Neue Tech., 5: 542-7(Sept. 1963). (In German)

The irradiation facilities in DIORIT and SAPHIR for the production of radioisotopes and the system for the transfer of the irradiated material to the hot laboratory are briefly described. The multipurpose cells for the processing of the irradiated material are discussed. The equipment and methods used for the preparation of I^{131}, colloidal Au^{198}, S^{35}, Y^{90}, I^{131}-labeled proteins, and I^{131}-labeled polyvinyl-pyrrolidon are described for illustration. (J.S.R.)

5714 PHOTOPRODUCTION OF URANIUM-237. Eiko Akatsu, Tokihiro Kuroyanagi, and Tomitaro Ishimori (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 2: 1-3(Oct. 1963).

A mixture of uranium dioxide and boric acid (1 : 10) was bombarded for one hour with 20-Mev bremsstrahlung from a linear electron accelerator. After bombardment uranium was chemically separated from fission products. The existence of U^{237} in the purified uranium, formed by (γ,n) reaction, was proved with the aid of beta and gamma spectrometry, and decay curve measurement. The radiochemical purity of U^{237} was 99.999% immediately after purification, and the specific activity 0.2 mC/g. It was found possible to prepare 1 mC of U^{237} from one gram of uranium dioxide in a bombardment of several hours' duration. (auth)

5715 APPLIANCE FOR SEPARATING FLUIDS BY DIFFUSION. Michelle Vulpillat and Serge Depaule (to Commissariat a l'Energie Atomique). British Patent 938,127. Oct. 2, 1963. Priority date Nov. 4, 1959, France.

The appliance described consists of a fluid-tight casing containing a plurality of diffusion elements in the form of sleeves of elongated cross section arranged in side-by-side parallel relation with their larger sides facing one another and separated by spacing means. A primary inlet, an outlet for fluid being treated, and a secondary outlet for the fraction of fluid diffused are provided. The opposite open ends of the interior of the sleeves communicate with the primary inlet and outlet, and the spaces between the facing walls of the sleeves communicate with the secondary outlet. The sleeves may be made entirely of a porous material or they may be made of metal with perforations covered by a porous material. Preferably the diffusion elements are so shaped that projecting parts of the diffusion walls themselves provide the spacing means. Struts may be placed between the diffusing walls to prevent possible deformation. The appliance is suitable for separating isotopes of uranium. (A.G.W.)

5716 PRODUCTION OF HEAVY HYDROGEN. Gustav Schaurer and Albert Heinzel (to Badische Anilin- and Soda-Fabrik Aktiengesellschaft). U. S. Patent 3,100,138. Aug. 6, 1963. Priority date Nov. 18, 1959, Germany.

A process for recovering heavy hydrogen during ammonia synthesis is proposed. It has been found that the heavy hydrogen behaves in the ammonia synthesis like an inert gas, and the residual gas becomes enriched in heavy hydrogen content when led several times over the ammonia catalyst. The proposed process then consists of reacting in a synthesis zone nitrogen gas and hydrogen gas to form ammonia, separating the ammonia formed from unreacted residual gases, replenishing the residual gases with fresh nitrogen and hydrogen, and repeating the steps until the amount of heavy hydrogen in the residual hydrogen is at least about 0.06 vol %. The heavy hydrogen is then separated from the remainder of the residual gases. Alternatively the heavy hydrogen content may be increased to about 0.6 to 0.8 vol % by leading the gas mixture 150 to 200 times over the ammonia catalyst. (A.G.W.)

5717 SEPARATION OF HYDROGEN ISOTOPES. Karl Erik O. Holmberg (to Quartz and Silice S.A.). U. S. Patent 3,101,256. Aug. 20, 1963. Filed Aug. 28, 1958.

An isotope separation process is described in which separation is partly achieved by distillation and partly by an isotope exchange equilibrium reaction. The process is based on the discovery that pyridinium chloride, the reaction product of equimolar amounts of pyridine and HCl, may be separated by distillation into species differentiated on the basis of the hydrogen isotope contained in the HCl component, since PyHCl has a boiling point of 222.5°C and PyDCl has a boiling point of 226°C. The process may be carried out by simply distilling pyridinium chloride, but in a preferred form, the pyridinium chloride is used as an intermediate product and an additional degree of separation is obtained by using water as the source of the isotope mixture and causing it to enter an isotope exchange reaction with the pyridinium chloride. The process may be carried out in a still and fractionating column of conventional design. (A.G.W.)

MATHEMATICS AND COMPUTERS

5718 (CERN-63-34) PROGRAMMING FOR HPD AND OTHER FLYING SPOT DEVICES HELD AT THE COLLEGE DE FRANCE, PARIS, AUGUST 21-23, 1963. J. M. Howie, S. J. McCarroll, B. W. Powell, and A. Wilson, eds. (European Organization for Nuclear Research, Geneva). Oct. 21, 1963. 274p.

Separate abstracts were prepared for twenty-three of the twenty-five papers included. Two papers on programs for scanning bubble chamber negatives and analyzing spark chamber data were previously abstracted for NSA. (D.C.W.)

For abstracts of individual papers see: 5608, 5609, 5610, 5611, 5612, 5613, 5614, 5615, 5616, 5617, 5618, 5619, 5620, 5621, 5622, 5623, 5624, 5625, 5626, 5627, 5719, 5720, and 5721.

5719 (CERN-63-34(p.125-32)) FUTURE PLANS FOR CERN HAZE. W. G. Moorhead and W. Krischer (European Organization for Nuclear Research, Geneva).

Difficulties with the HAZE program and desirable changes in the program are discussed. The FILTER and GATE routines are to be rewritten. (D.C.W.)

5720 (CERN-63-34(p.209-13)) DAPR. D. Hall (California. Univ., Berkeley. Lawrence Radiation Lab.).

The differences between the Digital Automatic Pattern Recognition system and its counterpart at Brookhaven National Laboratory are discussed. (D.C.W.)

5721 (CERN-63-34(p.223-9)) PAN 3—THE HPD DIAGNOSTIC PROGRAM. R. Glasser and S. J. McCarroll (European Organization for Nuclear Research, Geneva).

The computer program PAN3, used for testing the Hough-Powell Digitizer system for some of the more common faults that have appeared, is described. (D.C.W.)

5722 (KR-55) ON THE NUMERICAL CALCULATION ON BICKLEY FUNCTIONS. T. M. Danielsen, T. Havie, and R. J. J. Stamm'ler (Norway. Institutt for Atomenergi, Kjeller). Oct. 1963. 42p.

Applications and analytical properties of the Bickley functions $Ki_n(x) = \int_0^\infty (e^{-x\cosh u}/\cosh^n u)\, du$ are examined, and calculation of the functions from an integral representation and by using Chebyshev expansions or Everett's interpolation formula is discussed. Compressed tables of the first three functions are given along with second order "throw-back" modified differences for use with Everett's interpolation formula. A recurrence relation yields higher order functions. Tables of Chebyshev coefficients for the first three functions are also included. (D.C.W.)

5723 (ORNL-3499(Vol.I)(p.173-6)) COMPARISON OF LEAST-SQUARES ALGORITHMS. D. Bogert and W. R. Burrus (Oak Ridge National Lab., Tenn.).

Several different algarithms for solving the least-squares problem were tested numerically on a sequence of problems of increasing difficulty. The relative merits of the algarithms are discussed. (auth)

5724 (ORNL-3499(Vol.I)(p.177)) MODIFICATIONS TO THE 05R COMPUTER CODE. D. Irving (Oak Ridge National Lab., Tenn.).

Modifications to facilitate changes in the program and improve running time efficiency are underway. A subroutine for handling thermal neutrons in 05R was completed. (D.C.W.)

5725 (ORNL-TM-737) NORGE. A COMPUTER PROGRAM FOR THE GENERATION OF NORMALLY DISTRIBUTED RANDOM NUMBERS. C. A. Preskitt (Oak Ridge National Lab., Tenn.). Nov. 8, 1963. Contract W-7405-eng-26. 13p.

A program was written for the IBM-7090 computer that randomly converts a set of input numbers into a new set whose members are normally distributed about the input numbers with standard deviations equal to the square roots of the original numbers. (auth)

5726 (Y-1371) THE APPLICATION OF DATA PROCESSING TECHNIQUES TO A MAINTENANCE WORK CONTROL PROGRAM. J. D. Westbrook (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Aug. 7, 1963. Contract W-7405-eng-26. 157p.

The problem was to provide an effective reporting system, capable of feeding back information on the maintenance work control program, including the progress of the use of industrial engineering techniques and the effect of these techniques on maintenance work. The procedure followed to design and install this reporting system is generalized to provide a guide by which others may design reporting systems for work control programs. A manual reporting system was already in effect, and the manual reports formed the basis around which the electronic data processed reports were designed. Designing of reports was but one aspect of system design; also involved were: modification of timekeeping and time reporting procedures; redesign of standard forms and design of several new ones; and the alteration of planning and estimating rules. The results of these efforts are that the reporting system is an integral part of the maintenance work control program, and a method of designing reporting systems for work control programs was established. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 6412, 6493, and 6516.

5727 (AD-294579) INVESTIGATION OF MOLYBDENUM-BASE AND TUNGSTEN-BASE ALLOY SHEET MATERIALS. Final Report, May 1961 to July 1962. Gordon D. McArdle, Robert Q. Barr, and M. Semchyshen (Climax Molybdenum Co. of Michigan, Detroit). Jan. 15, 1963. Contract NOw 61-0581-d. 147p.

The production and properties of the following alloys are evaluated: Mo–1.35% Nb–0.028% C, Mo–1.17% Ti–0.27% Zr–0.15% C (TZC), Mo–25.4% W–0.10% Zr–0.037% C (WZM), Mo–49.1% W–0.014% C, and W–3.5% Mo–0.015% C. Bend transition temperatures and tensile and creep-rupture strengths of sheets rolled in air were relatively insensitive to finishing temperatures. Tensile transition temperatures were, however, lower for the sheets finished at the lower temperatures. The surfaces of sheets rolled in the InFab facility were found to be high in oxygen content. As a result, sheets processed in this manner displayed bend transition temperatures well above those of sheets of similar base composition rolled in air in a conventional manner. Removal of the contaminated surface layer by chemical-milling reduced the transition temperatures of the InFab-rolled sheets to values comparable to those of the air-rolled materials. The TZC and WZM alloys displayed good combinations of recrystallization, strength, and ductility characteristics. (N.W.R.)

5728 (ASD-TDR-63-270(Pt.II)) MATERIALS INVESTIGATION—SPUR PROGRAM. PART II. CREEP-RUPTURE PROPERTIES OF Mo + 0.5 w/o Ti. E. A. Kovacevich and R. L. Salley (Garrett Corp. AiResearch Mfg. Div. of Arizona, Phoenix). June 24, 1963. Contract AF33(657)-8954. 52p.

The creep-rupture properties of Mo + 0.5 wt % Ti are presented. Tests were conducted with specimens in helium, potassium vapor, and vacuum at 1500, 1800, and 2000°F. Results indicate that potassium vapor is not detrimental to the creep properties. The corrosive effects of potassium vapor on niobium alloys are evaluated. (N.W.R.)

5729 (ASD-TDR-63-744) EXPERIMENTAL STUDY OF FACTORS CONTROLLING THE EFFECTIVENESS OF HIGH-TEMPERATURE PROTECTIVE COATINGS FOR TUNGSTEN. C. D. Dickinson and L. L. Seigle (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). July 15, 1963. Contract AF33(657)-8787. 51p.

The oxidation at elevated temperatures of Zr–Th, Zr–Y, Hf–Y, Hf–W, Hf–W–Re, Al–Cr–Sn, and Al–La–Sn alloys, as well as ZrN, HfN, and ZrN–ThN combinations has been studied in order to clarify specific aspects of the problem of protecting tungsten against oxidation at high temperatures. Experimental results showed that there was much less tendency for ZrO_2, ThO_2, and HfO_2 scales to crack during growth at high than at low temperatures. Furthermore, multiphased scales were more resistant to spalling than single-phased scales, and protective oxides could be grown on many alloys. However, even in sound and coherent scales composed of these oxides, oxygen diffused so rapidly that it is doubtful that these oxides could form the basis of a protective system at 2000°C. The sequence of layers at the metal-air interface of the Zr–Th and Zr–Y alloys formed by diffusion-controlled oxidation was governed by a simple rule; namely, that the diffusion path in the appropriate isothermal section of the ternary equilibrium diagram is a straight line connecting the alloy composition with the oxygen corner. This rule is expected to apply to all ternary systems in which the oxidation process is dominated by the rapid diffusion of oxygen atoms in all layers. If significant migration of cations occurs, however, the rule is not applicable. Observations have been made of the rate of formation, nature, and morphology of scales formed on the brittle refractory compounds W_2Hf, ZrN, HfN, and ZrN–ThN, and those formed on liquid Zr–Y, Al–Cr–Sn and Al–La–Sn alloys. These observations are discussed in terms of their implications for the development of oxidation protection systems for tungsten at high temperatures. (auth)

5730 (BNL-827) CHEMONUCLEAR FISSION FRAGMENT SOURCE AND FUEL ELEMENT DEVELOPMENT PROGRESS REPORT. Meyer Steinberg and Gerald Farber (Brookhaven National Lab., Upton, N. Y.). Oct. 1963. Contract AT-30-2-GEN-16. 19p.

A U–Pd alloy containing up to 20 wt. % U^{235} was prepared and rolled into foil of 0.1 mil thickness. The foil can be etched to a thickness in the order of 0.05 mil. The alloy shows corrosion resistance in an air stream up to 1000°F. A 4-in. span of 0.1-mil foil was observed to be aerodynamically stable up to a gas velocity of 120 ft/sec. A fission fragment energy deposition efficiency of 63% was obtained with a U–Pd foil of 0.05-mil thickness. Preliminary burnup studies indicate little damage at low burnup and the importance of preventing fusion by proper cooling at high power densities. A honeycomb assembly of thin foil seems to be the most promising structural arrangement for a practical chemonuclear fuel element. A summary of the properties of the U–Pd material is given. (auth)

5731 (HW-68600-33) PLUTONIUM ABSTRACTS. Volume 3, Number 11. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1, 1963. Contract AT(45-1)-1350. 15p.

Twenty references, most in abstracted form, are presented on new developments in all areas of plutonium technology. The references are arranged into the following subject fields: chemistry, health and safety, metallurgy and ceramics, physics, and miscellaneous. (D.L.C.)

5732 (IITRI-B6007-5) DISPERSION-STRENGTHENED VANADIUM ALLOYS. Bimonthly Report No. 5, August 14, 1963–October 13, 1963. F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Nov. 8, 1963. Contract N600(19)59567. 17p. (AD-423428)

Vanadium–niobium alloys, dispersion-strengthened by additions of titanium, zirconium, or hafnium in combination with carbon, were prepared by arc-melting. Compositions containing 1 wt % hafnium with small carbon additions were more difficult to fabricate and have higher recrystallization temperatures than similar alloys containing zirconium and carbon. Short-time creep tests were conducted in 2000°F air on siliconized V–60 wt % Nb base specimens. At stress levels of 8500 to 8850 psi, creep values of 0.5 to 1.2% were measured in $2\frac{1}{2}$ hours. Some of the specimens retained their room-temperature tensile strength and ductility after stressing at 2000°F. These initial data indicate that V–60 wt % Nb alloys containing 1 wt % titanium with residual melting stock impurities

are more creep resistant at 2000°F than the alloys containing 1 wt % zirconium with 0.1 or 0.2 wt % carbon. (auth)

5733 (NAA-SR-8387) DIFFUSION KINETICS STUDIES IN THE Al–Ni–U SYSTEM. R. A. Harlow and Otto Gamba (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 30, 1963. Contract AT(11-1)-Gen-8. 33p.

A diffusion couple technique was developed and standardized for the purpose of obtaining meaningful data regarding the diffusion kinetics of the Al–Ni–U system. The technique entailed hot pressing under a dynamic vacuum and subsequent isothermal soaking treatments within evacuated quartz tubes for periods of 10 to 7000 hr at temperatures of 650, 750, 850, and 950°F. In addition, the nickel barrier bond between Type 1100 aluminum cladding and cast U–3.5% Mo fuel alloy was metallographically examined on four fuel cylinders fabricated according to Piqua procedure. One cylinder was inspected in the "as fabricated" conditions, and the three others after 1000, 2000, and 4000 hr of isothermal soaking in Santowax OMP at 750°F in an autoclave under 100 psig of nitrogen. The following conclusions were obtained: 1) The penetration of aluminum into nickel followed a parabolic relationship with time. The penetration coefficient was graphically determined as a function of temperature. 2) The nickel penetration data generated by the diffusion couple technique were slightly higher than those derived from the cylinder bond study. The maximum discrepancy was 20%. This disagreement was attributed to the geometry of the tubular specimens and to the interface displacements which occurred during the annealing process due to differential thermal expansion between fuel and cladding, both at the OD and ID. 3) A low-aluminum phase AlNi or $AlNi_3$ nucleated at the Al_3Ni/Al_3Ni_2 interface when the supply of additional free Al into the system was restricted due to void formation or separation between intermetallics and Al. The growth of the low-aluminum phase progressed at the expense of the Al_3Ni until all this phase was consumed, then consumption of the Al_3Ni_2 phase began. 4) The interdiffusion rate of uranium and nickel also followed the parabolic relationship with time. The diffusion coefficient as a function of temperature was plotted. (auth)

5734 (NMI-2121) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of September 1963. (Nuclear Metals, Inc., West Concord, Mass.). Nov. 19, 1963. Contract AT(30-1)-2784. 30p.

Methods of fabricating tungsten tubing by extrusion and drawing are discussed along with metallographic and mechanical properties. The effects of iron and silicon additions on single-crystal deformation in zone-refined beryllium are studied with respect to tensile and compression testing. The development of fabricating techniques for beryllium–uranium and copper–uranium alloys by SLIS techniques is evaluated. (N.W.R.)

5735 (NMI-2122) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the Month of October 1963. (Nuclear Metals, Inc., West Concord, Mass.). Dec. 10, 1963. Contract AT(30-1)-2784. 43p.

Methods of fabricating tungsten tubing by extrusion and drawing are discussed along with metallographic and mechanical properties. The effects of copper, iron, and nickel additions on single-crystal deformation in zone-refined beryllium are studied with respect to tensile and compression testing. The development of fabricating techniques for beryllium–Zircaloy–2, silver–uranium, and copper–uranium alloys by SLIS techniques is discussed. Fabrication and properties of extruded copper–uranium alloys are described. The hardness of splat cooled and compacted uranium alloys containing beryllium, carbon, and copper is compared with cast uranium and molybdenum–uranium alloy. (N.W.R.)

5736 (NP-13425) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report, January 1, 1963 through March 31, 1963. (Nuclear Metals, Inc., West Concord, Mass.). Aug. 1963. Contract AF33 (616)-7065. 29p.

The strength and ductility above room temperature of the hot-pressed Brush and Pechiney powders being studied at Lockheed show the usual behavior for beryllium. This material exhibits little response to aging heat treatments. Extruded Brush and Pechiney beryllium possess greater strength and ductility in the transverse direction than in the longitudinal direction at temperatures below about 20°C. This appears to be due to twinning in the longitudinal specimens. Tensile specimens are being prepared at Nuclear Metals from single crystals of SR Pechiney and of single distilled beryllium. These crystals were obtained from metal melted and slowly cooled in BeO crucibles. (auth)

5737 (PWA-2255) DETERMINATION OF THE EMISSIVITY OF MATERIALS. Progress Report, January 1 through June 30, 1963. R. J. Hayes (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). 6p. (N63-22882).

Emittance measurements were made and the long-term endurance tests were concluded. The total hemispherical emittance rig has been returned to service and the quality of temperature measurement has been investigated. An analysis of slurry coating procedures is being conducted. Total hemispherical emittance measurements were made and are reported for AISI-310 stainless steel, tantalum, and coatings of crystalline boron, nickel-chrome spinel, calcium titanate, and iron titanate. All coating materials were plasma-arc sprayed onto niobium–1 per cent zirconium tubes. Emittance values of 0.87 or above were obtained with coatings of nickel-chrome spinel, calcium titanate, and iron titanate. An endurance test conducted on a calcium–titanate coated specimen resulted in lower emittance values than anticipated but these values are not believed to be characteristic of this coating. Endurance tests were not completed for nickel-chrome spinel or iron titanate coatings. An aluminum-phosphate bonded mixture of nickel-chrome spinel and silicon dioxide on a SNAP-8 finned-tube radiator segment completed 15,000 hours of endurance testing. Flame-sprayed coatings of titania on SNAP-8 and Sunflower I sections completed 14,037 and 13,755 hours respectively. A fourth rig containing a SNAP-8 section with an aluminum-phosphate bonded mixture of silicon carbide and silicon dioxide completed 12,781 hours of testing. All tests have been terminated and the coated segments are being maintained in vacuum at ambient temperatures pending post-test analysis. The difficulties arising from the volatilization of manganese oxide in the total hemispherical emittance rig have been resolved and the rig was returned to service. The quality of black-body hole configurations was re-evaluated and results substantiated previous analytical work. The new evaluation included the investigation of the effects of specimen misalignment and variations in chamber geometry. In conjunction with these investigations it has been found that, on the average, optical pyrometer temperature indications are 6°F higher than thermocouple indications. This prob-

lem is under investigation. An investigation of Alkaphos-bonded coating procedures was conducted with attention being directed toward the bonding of silicon carbide. Nineteen tests were conducted using various surface preparation, drying, and curing procedures as well as various slurry compositions. The best procedure found to date requires 20 hours of air drying followed by oven curing at 200°F for 2 hours, 250°F for 2 hours, 300°F for 2 hours, and 400°F for 2 hours. (auth)

5738 DEVELOPMENT OF TANTALUM ALLOYS FOR CAPSULES FOR LIQUID PLUTONIUM. Richard M. Bidwell (Instituto de Energia Atomica, Sao Paulo, Brazil). ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo), 19: 539-55 (1963). (IEA-64). (In Spanish)

The studies made in the development of tantalum alloys to be used as receptacles for liquid Pu in nuclear reactors are described. The effects of alloying elements and interstitial impurities are discussed. (tr-auth)

5739 PRESENT STATE OF TECHNOLOGY FOR THE PRODUCTION OF METALLIC THORIUM. Heliton M. Haydt (Instituto de Energia Atomica, Sao Paulo, Brazil). ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo), 19: 571-8 (1963). (IEA-63). (In Spanish)

Because of the importance of the mineral reserves of Th in Brazil, the Comissão Nacional de Energia Nuclear has emphasized the development of thorium–plutonium reactors for energy production. The present state of technology for the production of metallic Th, beginning with thorium oxide, is summarized. The principal steps of the process—the fluorination with dry gaseous HF, the reduction by metallic Ca of the ThF_4 in the presence of zinc fluoride, and the subsequent steps of pre-fusion and final fusion with ingot production in electrical furnaces with consumable electrode—are described. (tr-auth)

5740 NEW ERA OF CERAMICS. Eugene Ryshkewitch (National Beryllia Corp., Haskell, N. J.). Trans. N. Y. Acad. Sci., 25: 827-45(June 1963).

The production, properties, and applications of ceramics, especially of sintered alumina, beryllia, zirconia, thoria, and urania, are surveyed. Other examples of oxide ceramics, titanates, ferrites, and other spinels, are briefly discussed. (BBB)

5741 RADIOACTIVE TRACERS IN PHYSICAL METALLURGY. C. Leymonie, ed. Translated from French by Vernon Griffiths. New York, John Wiley and Sons, Inc., 1963. 220p.

A comprehensive account is given of the scientific applications of radioactive tracers in physical metallurgy. After an introduction to radioisotopes, the following applications are discussed: diffusion (with emphasis on Russian work), segregation, corrosion and oxidation, friction and wear, and vapor-condensed phase equilibria in slags. (D.L.C.)

Corrosion

5742 (CONF-243-35) A SYSTEM FOR MEASUREMENT OF WALL THICKNESS OF CORRODED ALUMINUM REACTOR PROCESS TUBES. Ralph V. Dulin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [1954]. Contract AT(45-1)-1350. 18p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A sector gage was developed for routine measurement and recording of wall thicknesses between the ribs and at the top of installed aluminum reactor power tubes. The basic criteria selected for the device were that it would measure and record wall thickness over the length of the tube with an accuracy of ±2 mils at an average rate of 3 min per tube. An eddy-current measuring system was used in the device. (M.C.G.)

5743 (HW-78819) EFFECT OF LITHIUM HYDROXIDE LEAKAGE ON THE HIGH-TEMPERATURE CORROSION OF ZIRCALOY-2. H. P. Maffei (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 12, 1963. Contract [AT(45-1)-1350]. 7p.

The corrosion and hydriding rates of Zircaloy-2 are greatly increased by high concentrations of LiOH in high temperature water. The possibility exists that this type of corrosion may be of concern in reactor systems employing Zircaloy pressure tubes and a coolant adjusted to pH 10 with LiOH. Concentrations of lithium hydroxide could occur at a steam water interface (e.g. a leak at a rolled or flanged joint between pressure tube and nozzle). Two experiments to simulate concentration of LiOH at a leaking mechanical joint have each resulted in corrosion approximately 100 times greater than the corrosion of Zircaloy-2 in pH 10 water at the same temperature (300°C) and for the same period of time. Polished cross sections of the highly corroded areas revealed only a small amount of hydriding (100 ppm). This was probably due to the small area of accelerated corrosion and the relatively large volume of sample. The corrosion product hydrogen absorbed could therefore be distributed in the bulk of the sample at levels of less than 100 ppm. (D.L.C.)

5744 (KR-53) ADVANCED COURSE ON CORROSION AND WATER TREATMENT PROBLEMS IN WATER COOLED POWER REACTORS ORGANIZED BY THE NETHERLANDS'–NORWEGIAN REACTOR SCHOOL AT INSTITUTT FOR ATOMENERGI, KJELLER, NORWAY, AUGUST 19–AUGUST 30, 1963. (Netherlands'–Norwegian Reactor School. Advanced Study Inst., Kjeller, Norway). 371p.

Twenty lectures are presented on various topics related to corrosion and water treatment problems in water-cooled power reactors. Among the materials considered are stainless steel, high-Ni alloys, carbon steel, steels, Zr alloys, and Al. Fuel canning and superheater materials are also considered. Radiolysis of water and ion exchange resins in reactors are discussed. (D.L.C.)

5745 (SC-TM-307-63(14)) PLASMA ANODIZATION OF VACUUM-EVAPORATED ALUMINUM THIN FILMS. L. E. Terry and E. E. Komarek (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract [AT(29-1)-789]. 21p.

Vacuum evaporated aluminum films were subjected to a glow discharge plasma established in a partial pressure of oxygen to promote growth of Al_2O_3 films. The Al_2O_3 films have an average growth rate of 42 Å per bias volt in the thickness range up to approximately 450 Å. Growth and quality of the oxide film depends upon the purity of the oxygen, geometrical positioning of the film with respect to the glow discharge electrodes (and hence field concentration), and anodization time. Dielectric field strengths of 8×10^6 v/cm are obtained for the plasma anodized Al_2O_3 films. (auth)

5746 ELECTRON METALLOGRAPHY OF THE CORROSION OF BERYLLIUM AND BERYLLIUM–CALCIUM ALLOYS. V. D. Scott and G. V. T. Ranzetta (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Mater., 9: 277-89(Aug. 1963).

The oxidation of beryllium and a beryllium–0.7 wt % calcium alloy in (CO_2 + 2% CO) containing water vapor was

investigated by electron microscopy, electron diffraction, and electron-probe microanalysis techniques. The most significant effect of adding calcium to beryllium was to reduce the extent of intergranular oxidation of the metal. Although the surface oxide scale formed on both grades of material was found to be closely similar, consisting of platelets of beryllium oxide (several 1000 Å diameter) together with localized regions of enhanced attack that contained some beryllium oxide whiskers, sub-surface regions of the corroded alloy were found to contain a layer enriched with calcium. It is proposed that this layer contributes to the mechanical stability of the oxide and may also act as a diffusion barrier between the gas and the unreacted metal. In the absence of evidence concerning the formation of a calcium-bearing corrosion product, it is further suggested that the enrichment may be associated with a thin layer of $Be_{13}Ca$ covering the alloy surface. (auth)

5747 A RADIOTRACER STUDY OF Cs^+ AND Cl^- DEPOSITION ON STEELS AND ZIRCALOY-2 IN ALKALINE WATER SYSTEMS. E. Hesford, J. Williams, and G. N. Walton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Radiochim. Acta, 2: 14-19(Oct. 1963). (AERE-R-4069)

A radiotracer study was made of cesium and chloride ion deposition on mild steel, premagnetited mild steel, stainless steel, and Zircaloy-2 specimens under oxidizing conditions at room temperature and oxygen-free conditions at room temperature and 60°C. The results show that under any of the conditions examined uptake on stainless steel and Zircaloy is low. With mild steel, uptake is only low when the surface is premagnetited, and exposed to deoxygenated water at elevated temperatures. Results for anion deposition are interpreted with reference to the electrode potentials of the surfaces. Cation deposition is unrelated to electrode potentials and appears to be associated with the hydrous character of the oxide film. (auth)

Fabrication

5748 (AD-423723) DIFFUSION BONDING: AN ANNOTATED BIBLIOGRAPHY. Scott J. Buginas, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Mar. 1963. Contract NOw 63-0050-C. 33p. (SB-63-44)

This bibliography contains 89 selected references on hot pressure welding and diffusion bonding from the years 1940–1962. Indexes are included. (auth)

5749 (ANL-6550) THE MANUFACTURE OF SUPPLEMENTAL DEPLETED FUEL RODS FOR FCF STARTUP. N. J. Carson, Jr., H. F. Jelinek, and A. B. Shuck (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 29p.

Approximately 2000 supplemental rods were made for use in EBR-II Fuel Cycle Facility startup tests. They were made in the same manner as Core-I fuel rods but using partially depleted pins instead of fuel pins. A "duplex" or double melting operation was used for Core-I production. The alloys were first melted together and cast in an ingot mold. The ingot was then remelted and injection cast to produce fuel pins. In order to simplify the operation, a single melt, or "simplex" operation, alloying and injecting casting in one step was tried. This operation was unsatisfactory because of uncontrollable gas evolution from the ingredients of the charge. The interior parts of the furnace became coated with condensed metal to an extent that threatened mechanical and electrical failure of the furnace. A thermocouple head was developed for use in the injection casting furnace. It had increased accuracy and reliability, and was more easily remotely replaced. The improvements were due to unit construction and improved cold-junction contacts. A statistical analysis was made of a sample of 412 rods. The analysis produced (1) an equation for predicting sodium levels through the selection of sodium loads, and (2) evidence that jacket-preassembly classification is necessary under existing specifications for sodium level. (auth)

5750 (CEND-157) THE DEVELOPMENT AND TESTING OF UO_2 FUEL SYSTEMS FOR WATER REACTOR APPLICATIONS. Summary Report, July 1, 1961–June 15, 1962. B. E. Murtha and W. P. Chernock (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-2863. 170p. (EURAEC-597)

Vibratory Compaction. Densities of 89 to 90% of theoretical were obtained in 4- to 6-ft long fuel rods, and a pneumatic vibratory compaction process was developed for fuel rod ID of 0.34 to 0.45 inch. A study was made of the variables in the pneumatic compaction process. The problem of low-density regions at the bottom one to two inches of the fuel column was reduced by predensification techniques. Swaged Fuel Elements. The possibility of combining vibratory compaction and small swaging reductions to produce powder packed fuel element densities greater than 90% of theoretical, was studied using stainless steel-clad fused UO_2 fuel rods. The final products had densities of 92 to 93% theoretical and maximum OD variations of ±0.001 inch. Cost analyses of the process combination show lower fuel cycle costs as compared to vibratory compaction alone. Projection Welding. A multiple-electrode tool capable of simultaneously welding nine fuel rods to a wire spacer is described. An initial study of welding parameters was made using stainless steel tubing. The mechanical problems of stacking and welding of a full-size hexagonal cluster were considered, and a cluster assembly method was evolved which minimizes cluster movement and fabrication time. Development of refined parameters for cluster configurations is in progress. Reduction in Cladding Thickness. Two methods were evaluated for minimizing the cladding thickness in stainless steel-clad fuel elements. One method is the use of higher strength, work hardened cladding. A series of collapse tests were performed on samples with various degrees of cold work hardened wall thicknesses and diameters, and a reasonably accurate criterion was developed for predicting tube collapse of annealed and hardened tubing. The other method is the use of the fuel for internal support of thin cladding. The effects of pellet diameters, defects, and compacted powder density on this method was studied. Several ways of supporting the clad in the fission gas void region above the fuel column were also studied. Rock Riting. An attempt was made to reduce a series of stainless steel tubes containing fused UO_2 by the Rock Rite process. Buckling problems were encountered due to an axial compression load on the unreduced portion of the rods, but ten rods were processed at reduced feed rates and area reductions of 20 to 39%. Rods initially densified to 75% of theoretical and reduced in area 39% resulted in final gross density of 91.5% of theoretical. Symposium on Powder Packed Uranium Dioxide Fuel Elements. General summaries of each of the five major areas of technology reviewed at this symposium are presented. (D.L.C.)

5751 (HW-66354) COMPARISON OF AC AND DC FOR WELDING ALUMINUM-CLAD FUEL ELEMENTS. G. R. Hanson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 26, 1960. Contract [AT(45-1)-1350]. 21p.

D-c welding was found to be far superior to a-c welding for aluminum-clad fuel elements. Three comparison tests were made involving 1700 fuel elements, and it was found that with d-c there was a 77% decrease in pinholes, a 34% decrease in weld cracking, and a 44% increase in braze mixing. It was also found that d-c welding solved many of the present operating problems, such as obliteration of stamping, oxides due to poor arc strikes, melting of the contour, and oxide problems resulting from a deformed electrode. In addition, the weld height was found to be much more uniform than the height of the present a-c welds. Some revisions to the present weld-inspection standards will be required since the d-c weld had a thin film of oxide at the edges of the weld. There was a 19% decrease in total weld rejects with d-c. Thus, an increase in production weld rejects is not anticipated. About 3500 fuel elements were welded using varied welding conditions, and it was found that a double pass, 25-rpm weld using helium shielding gas was optimum for d-c welding. Additional helium will be required for this weld; however, no problems are anticipated in procuring the additional helium. There will be a reduction in the operating cost with d-c, but this reduction will be offset by the cost of the increased helium consumption. Consequently, it is expected that the welding costs for d-c will be about the same as for a-c. (auth)

5752 (WANL-PR(P)-001) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Quarterly Report No. 1, June 21, 1963 to September 21, 1963. G. G. Lessmann and D. R. Stoner (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS 3-2540. 65p.

A research program was initiated to determine the weldability and long-time thermal stability of promising refractory metal alloys for possible use in advanced alkali-metal space electric-power systems. Seven Nb-base alloys, three Ta-base alloys, W–25 Re, and pure W were selected for evaluation, and procurement of the alloys has been started. Alloy specifications and background information (tensile properties and bend ductility test results) are given. Preliminary electron beam welding was carried out on two Nb alloys and two Ta alloys. Equipment design for the welding studies is discussed. (D.L.C.)

5753 FUEL DEVELOPMENTS AND IRRADIATIONS AT RCN. B. Verkerk (Kernforschungszentrums, Petten, Ger.). Atomwirtschaft, 8: 599-602(Nov. 1963). (In German)

In 1959 a fuel development program was undertaken based on UO_2 in which it was intended to study all variables that could influence the quality of fabricated UO_2-pellets. Later this program was extended to a study of electrolytic UO_2 with the fabrication of swaged or vibratory compacted fuel elements in mind, and recently the study of the UO_2–PuO_2 system was incorporated in it. In order to obtain a better knowledge of the UO_2-powders that can be used for sintering purposes, an extensive study was made of various preparation methods. A small plutonium laboratory containing equipment for the preparation of UO_2–PuO_2 pellets containing 1 to 10% PuO_2 was set up and preliminary experiments were performed. Work on a small scale was done on pressing and sintering of UO_2 made along various routes. The reduction process was also studied. For the regeneration of scrap, especially for the case of enriched material, a 5-kg batch dissolution and precipitation plant was built. This installation is also used for various precipitation studies on a larger scale. Within the scope of the fuel development program the study of canning materials is also of great importance. For the ship-propulsion reactor Zircaloy-2 was chosen as canning material. Various welding experiments were done in an argon-arc welding chamber and it was found that under well selected conditions very satisfactory end-cap welds could be obtained. In the corrosion program it became clear that proper conditioning is of utmost importance. Means of pre-operation treatment are being studied. In the HFR a low-temperature, low-pressure loop for the irradiation of capsules is in regular operation. The pressurized loop now under construction was designed for testing of fuel rods and clusters as planned for the ship-propulsion reactor, under conditions close to those of the actual reactor. The facilities for the post-irradiation measurements consist of two lead cells. (auth)

5754 MEASUREMENT OF THE ELECTRON WORK FUNCTION OF MOLYBDENUM AND TANTALUM AFTER COLD DEFORMATION UNDER CONDITIONS OF VERY HIGH VACUUM. L. A. Andreev and Ya. Palige (Moscow Steel and Alloy Inst.). Dokl. Akad. Nauk SSSR, 152: 1086-8(Oct. 11, 1963). (In Russian)

The relative change in electron work function ϕ during the cold deformation of molybdenum and tantalum was determined by measuring the contact difference in potential under a high vacuum of 10^{-9} to 10^{-10} mm. The unit consists of a measuring section, which includes a calibrated Mo wire and the test wire, a glass-enclosed iron core in order to deform the sample, and a high-vacuum section consisting of a Ta getter, an Alpert pump and liquid nitrogen traps. The unit was outgassed for a long time at 400 to 450°C in a vacuum of 10^{-5} to 5×10^{-6} mm. The test wire was periodically heated to 2200°C in order to obtain a clean surface. The difference in work function $\Delta\phi$ in a given case was taken as the difference in contact potential before deformation to the contact potential after deformation. It was found that the value of ϕ decreases 15 to 20 millivolts with a deformation of 3 to 5% for molybdenum and tantalum. The decrease in ϕ may be due to the formation of surface defects or to an increase in surface area during deformation of the metal. (TTT)

5755 STUDY ON THE EXTRUSION PROCESS OF SILVER–INDIUM–CADMIUM ALLOY FOR CONTROL ROD OF LIGHT WATER REACTOR. Michio Mizuta, Kiyoshi Hashimoto, and Michio Kato. Nippon Genshiryoku Gakkaishi, 5: 903-8(Nov. 1963).

To obtain fundamental informations on the fabrication technology of a control rod absorber of Ag-15 wt % In-5 wt % Cd alloy, which was developed considering the Hume-Rothery electron concentration rule, some experiments were performed. By the hardness tests on alloys obtained in several steps of cold rolling and subsequent annealing, the alloy was confirmed to have good workability. The cast alloy was able to be extruded at 700°C in round rods. The value of extrusion coefficient K was determined to be about 15 kg/mm^2 at 700°C. The tensile properties and microstructures of extruded rods were also studied. (auth)

5756 TECHNOLOGY FOR ISOTOPE-ENRICHED FOILS OF CHROMIUM AND IRON FOR NUCLEAR RESEARCH. V. P. Bochin and S. A. Repin. Pribory i Tekhn. Eksperim., No. 5, 212-14(Sept.-Oct. 1963). (In Russian)

The techniques for producing foils of thickness 0.5-2 mg/cm^2 from isotopes of iron and chromium are described. The size of the losses of isotopes are also discussed. (tr-auth)

5757 EXPERIENCE WITH STATISTICAL QUALITY CONTROL IN PRODUCTION SINTERING OF URANIUM DIOXIDE. Gunnar Jakobsen and Steinar Aas (Institutt for

Atomenergi, Kjeller, Norway). Tidsskr. Kjemi, Bergvesen Met., 23: 171-4(Oct. 1963). (In Norwegian)

Some experiences with statistical quality control in the manufacturing of sintered UO_2 for the reactor and experimental use are described. The method was used for control of the pressing of green pellets and revealed a systematic drift in the process. The sintering furnaces were shown to give a product with properties varying according to position in the furnace. The drift in the pressing operation and the variation in sintered density according to position can be used to obtain a very uniform product. (auth)

5758 DEVELOPMENT OF ALLOYS FOR BRAZING COLUMBIUM. C. W. Fox, R. G. Gilliland, and G. M. Slaughter (Oak Ridge National Lab., Tenn.). Welding J., (N. Y.), 42: 535-s-40-s(Dec. 1963).

In view of the lack of suitable brazing alloys, several hundred different binary and ternary alloys were investigated specifically for joining Nb. Ten of the most promising alloys were evaluated through thermal cycling and aging tests and mechanical shear strength determinations. The results indicate that the alloy compositions, 48 Ti–48 Zr–4 Be and 75 Zr–19 Nb–6 Be (wt %), are particularly promising for a wide variety of joining operations on Nb. (P.C.H.)

5759 IMPROVEMENTS IN OR RELATING TO SINTERED METAL TUBES. Michel Eudier (to Commissariat à l'Energie Atomique). British Patent 937,573. Sept. 25, 1963. Priority date Mar. 11, 1960, France.

In the method described for manufacturing sintered metal tubes, a mixture of powdered metal and a binding agent are formed into a tubular shape and located with a clearance of at least 0.5 mm in an outer tube of refractory material. The outer tube is disposed at an angle of 5° to 30° to the horizontal plane, and the assembly is rotated at a speed corresponding to at least one revolution during time equal to the period required for sintering the metal. The metal is sintered by displacement of an annular furnace along the outer tube from the bottom to the top with a speed of displacement sufficient to allow sintering of the inner tube. A sintering temperature of 600 to 1200°C and an overall sintering time of 10 to 60 min are provided. A stream of hydrogen or other reducing gas is passed through the refractory tube during sintering. (A.G.W.)

5760 IMPROVEMENTS IN AND RELATING TO EXTRUSION APPARATUS AND PARTICULARLY TO MEANS FOR EXTRUDING GRAPHITE. Austin Buckle Miller (to C. A. Parsons and Co. Ltd.). British Patent 937,991. Sept. 25, 1963. Filed Jan. 7, 1960.

The extrusion apparatus described consists of a ram operating in a cylinder to force material through an extrusion die at one end of the cylinder. A grid device is located in the die intermediate between the inlet and outlet. Continuous compression in a direction transverse to the extrusion axis is provided during and after passage of the material through the grid, so that an extruded block of cohesive material is produced. Preferably the members forming the grid are disposed radially with respect to the extrusion axis and are profiled to assist the flow of material through the grid. In passing the material through a grid, working of the material takes place in the vicinity of each member forming the grid, and a more uniform product is obtained. (A.G.W.)

5761 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL RODS. (to Societe Indatom). British Patent 938,405. Oct. 2, 1963. Priority date Jan. 27, 1959, France.

The fuel rod considered comprises a plurality of tablets of a ceramic fissile material contained in a metal sheath. The tablets are separated from one another by layers of a substantially better conductor of heat than the ceramic fissile material. The tablets are composed of uranium oxide, plutonium oxide, or a mixture of fissile and fertile oxides. The conductive material is selected from the group comprising the oxides of Al, Mg, and Be. The tablets of fissile material and the separating layers may be produced separately by a first compressing operation and then united by means of a final compression to ensure their intimate connection. (A.G.W.)

5762 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SPHEROIDS. Neville Ronald Williams (to United Kingdom Atomic Energy Authority). British Patent 938,671. Oct. 2, 1963. Filed June 12, 1961.

Spheroids may be produced by placing particles in an annular dish having an abrasive surface and applying a gyratory vibration to the dish in such a manner that the particles move around the dish until substantially spheroidal. The dish may be provided with a plurality of abrasive lined circular grooves in its inner surface for large batch production of spheroids or alternatively dishes having an abrasive-lined spiral groove in their inner surface may be used singly or in series to provide a continuous spheroidizing process. The gyratory vibration may be produced by means of an out-of-balance flywheel rotating about a vertical axis in bearings secured to a support for the dish as in known gyratory sieve machines. Details of the production of dense spheroids from UO_2 powder are given. (A.G.W.)

5763 COUPLING. Erling Frisch and Carl G. Johnson (to Westinghouse Electric Corp.). German Patent 1,156,517. Oct. 31, 1963. Priority date July 22, 1957, United States.

A detachable coupling arrangement is described that is adapted for use in applications imposing severe space limitations to the cross-sectional configuration of the parts to be joined. The coupling is adapted particularly for use with connecting rods, which are inserted into relatively closely fitting channels, e.g., into the channel of a nuclear reactor core. The coupling arrangement is provided with key and keyhole formations, respectively, on the members to be coupled which can be formed integrally with the members being joined by the coupling. The coupling is further arranged such that the formations do not protrude beyond the exterior surfaces of the elements being joined by the coupling. (Gmelin Inst.)

5764 POROUS MEMBRANES AND METHODS OF MANUFACTURING THESE MEMBRANES. Gilberte Moutaud and Jean Parisot (to Commissariat a l'Energie Atomique). U. S. Patent 3,102,826. Sept. 3, 1963. Priority date Oct. 15, 1957, France.

In the method described for manufacturing porous membranes, polytetrafluoroethylene powder is thoroughly mixed with absolute alcohol in excess to form a paste. The excess alcohol is removed until only about 40% by weight remains. The paste is then applied on a metal wire fabric and the wetting substance is eliminated by drying at a suitable temperature. The paste may be treated to remove impurities before it is applied to the metal wire fabric. (A.G.W.)

5765 ZIRCONIUM-BASE BRAZING ALLOYS. Robert E. Droegkamp, Edward R. Slaughter, and Alfred B. Thomas (to Westinghouse Electric Corp.). U. S. Patent 3,104,972. Sept. 24, 1963. Filed Oct. 17, 1960.

Corrosion-resistant brazing alloys for use in the joining of Zr-base alloy members are suggested. The brazing alloys contain 3 to 8% Be and at least one metal additive selected from the group consisting of Cu, Fe, and a Cu and Co combination in a Zr-base master alloy containing up to

2.5% Sn, up to 2% of at least one metal selected from the group consisting of Fe, Ni, and Cr, C not exceeding 0.05%, and the balance at least 94% Zr with less than 0.5% by weight of incidental impurities. The brazing alloys have a melting point of approximately 820°C and form a well-bonded joint without the use of a flux. (A.G.W.)

5766 MOLDING APPARATUS. P. G. Fleming (to U. S. Atomic Energy Commission). U. S. Patent 3,105,995. Oct. 8, 1963.

Molding apparatus capable of coating multiple elements each molding cycle is described. The apparatus comprises a centrally disposed reservoir penetrated by a plurality of circumferentially arranged and radially extending passageways. These passageways, in turn, communicate with passages in a separable annular member that retains selectively configured molds and mold seating arrangements. Each mold, which is readily removable from its respective seat, is adapted to retain an element therein in spaced relation to the interior of the mold by utilizing element positioning means within the mold seat and the mold so that coating material may flow about the entire outer surface of the element. (AEC)

5767 LIQUID PHASE SINTERING OF METALLIC CARBIDES. J. Hammond and J. D. Sease (to U. S. Atomic Energy Commission). U. S. Patent 3,118,764. Jan. 21, 1964.

An improved method is given for fabricating uranium carbide composites. The method comprises forming a homogeneous mixture of powdered uranium carbide, a uranium intermetallic compound which wets and forms a eutectic with said carbide and has a non-uranium component which has a relatively high vapor pressure at a temperature in the range 1200 to 1500°C, and an organic binder, pressing said mixture to a composite of desired green strength, and then vacuum sintering said composite at the eutectic forming temperature for a period sufficient to remove at least a portion of the non-uranium containing component of said eutectic. (AEC)

Properties and Structure

5768 (AAEC/TM-217) A METHOD FOR MEASURING THE DENSITIES OF SINGLE CRYSTALS OF BERYLLIUM OXIDE. R. J. Hemphill and G. L. Hanna (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1963. 9p.

A method is described whereby the density of a single crystal of beryllium oxide can be measured by suspending it in a dense liquid. The method is being used to measure radiation-induced changes in density and is sensitive to 1 part in 10^5. The absolute accuracy has not been established owing to the lack of a suitable standard. (auth)

5769 (AD-290278) AN INVESTIGATION OF THE CRACK-PROPAGATION RESISTANCE OF HIGH-STRENGTH ALLOYS AND HEAT-RESISTANT ALLOYS. Summary Technical Report, December 23, 1960 through October 23, 1962. J. D. Morrison, P. C. Jenkins, J. R. Kattus (Southern Research Inst., Birmingham, Ala). Nov. 21, 1962. Contract NOw-61-0392-d. 107p.

The purpose of this program was to determine the crack-propagation resistance of super-alloy and refractory-metal sheet materials and to investigate certain aspects of the elevated-temperature mechanical behavior of high-strength low-alloy steels. Sheet specimens containing central transverse fatigue cracks were used in the experimental work. It was found that the fracture toughness of the nickel-base alloys—Rene' 41, Nimonic 90, Inconel-X, and Unitemp 1753—decreased slightly in the temperature range from about 1000 to 1400°F, in which temperature range there were generally increases in ultimate tensile strength and decreases in tensile elongation. The alloys A286 (iron-base) and L605 (cobalt-base) did not show this brittleness tendency. Among the refractory metals, unalloyed molybdenum was found to have a brittle-ductile transition temperature of about 150°F; the molybdenum alloys—Mo-1/2%Ti and TZM—both had transition temperatures of about 65°F. Unalloyed tungsten sheet, containing sharp notches rather than fatigue cracks, showed an increasing tendency to brittleness below about 500°F. Two columbium-base alloys—D-14 and FS82—were ductile over the temperature range investigated—from −320°F to about 1000°F. In an investigation of apparent strain-aging effects in steels, it was found that greatly increasing the rate of loading diminished the net-fracture-stress minimum that occurs at around 300°F at slow loading rates. The program also included an evaluation of the compliance gage, originally developed at the U. S. Naval Research Laboratory, for the determination of critical crack length. It was found that, by means of this device, critical crack length can be reproducibly measured in crack-propagation tests over a wide temperature range. Used with certain types of crack-propagation specimens, such as the shear-cracked specimen, the gage apparently gives a reliable measure of the plane-strain fracture-toughness parameters, K_{Ic} and G_{Ic}. (auth)

5770 (ASD-TDR-62-323) ANELASTIC BEHAVIOR OF TANTALUM AND COLUMBIUM. R. J. Sneed, E. L. Fink, and M. C. Abrams (General Dynamics/Pomona. Div. of General Dynamics Corp., Pomona, Calif.). Nov. 1962. Contract AF33(616)-7235. 121p. (AD-401811)

A theoretical model is developed based on dislocation-interstitial interaction during stress application, which describes the anelastic behavior of bcc metals particularly during yield delay. It is shown that the reorientation of interstitial impurities apparently controls both the preyield microstrain rate and the time to yield. The model is supported for tantalum and niobium by the results of yield-delay experiments over a temperature range from −97°F to 400°F. Activation energies of the yield-delay process, calculated both from microstrain rate data and time-to-yield information indicate that hydrogen diffusion has a controlling effect, with other interstitials contributing to the effective activation energies at the higher temperatures. Temperature-insensitive stress effects are noted. The model is further substantiated by x-ray diffractometry which demonstrates the occurrence of anelastic lattice strains during load application and their consequent recovery. A brief résumé is given on the initial efforts of a high-temperature study on the anelasticity in tantalum and columbium. This study is aimed at exploring anelastic behavior up to 3000°F. (auth)

5771 (AWRE-O-49/63) THE PERMEATION AND DIFFUSION OF HYDROGEN ISOTOPES IN Nilo-K. P. M. S. Jones, R. Gibson, and N. J. McKenna (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1963. 24p.

The permeation and diffusion of hydrogen and deuterium in Nilo-K was studied over the temperature range 40 to 400°C. The permeation is shown to follow a root pressure relationship down to 5 cm pressure at 60°C, and the ratios P_{H_2}/P_{D_2} and D_{H_2}/D_{D_2} found to be 1.35 ± 0.03 and 0.96 ± 0.10 respectively. The values for the hydrogen permeation and diffusion constants are given by $\log_{10} P$(std.ml/cm^2 sec

$At^{0.5}/mm) = -2.084\ (\pm 0.047) - 2629\ (\pm 37)/T^0K$, and $\log_{10} D(cm^2/sec) = -2.792\ (\pm 0.106) - 2262\ (\pm 56)/T^0K$. (auth)

5772 (BMI-X-266) PROGRESS ON USAEC/AECL COOPERATIVE PROGRAM. Quarterly Report, September 1963–November 1963. Stanley W. Porembka (Battelle Memorial Inst., Columbus, Ohio). Dec. 11, 1963. Contract W-7405-eng-92. 17p.

The program to determine the effect of long-time exposure (to 20,000 hr) on the creep-rupture strength of three sintered aluminum powder alloys was continued. The alloys were SAP-895, M-257, and SAP-915. Temperatures of interest were 700, 800, and 900°F. Results of creep-rupture tests from 1 to 1000 hr at each temperature are presented and progress on long-time tests is described. Research is also being carried out to obtain creep and creep-rupture data on annealed and cold-worked Zircaloy-2 sheet. Temperatures of interest ranged from 450 to 750°F. Results are presented for times from 19,400 to 52,900 hr. (M.C.G.)

5773 (CONF-339-2) EFFECT OF PURIFICATION ON BASAL CLEAVAGE IN BERYLLIUM SINGLE CRYSTALS. E. D. Levine, D. F. Kaufman, and L. R. Aronin (Nuclear Metals, Inc., Concord, Mass.). [1963]. Contract AT(30-1)-1565. 25p.

From The Metallurgical Society of AIME, Fall Meeting, Cleveland, Oct. 1963

The deformation of impure beryllium crystals by basal glide at room temperature invariably terminates by basal cleavage after a few percent strain. It is generally accepted that fracture of this type is caused by the splitting of low-angle boundaries, or bend planes, by obstacles that restrict the motion of the bend planes in the deforming crystal. The details of such a process have been developed by Stroh, who showed that the high tensile stress normal to the basal plane in the region where the bend plane is split results in the propagation of a basal cleavage crack, provided there is no available deformation mode having a shear component normal to the basal plane. It has been postulated that purification of beryllium might lead to increased basal ductility by the removal of barriers to bend plane motion and possibly by the activation of non-basal deformation systems. Large increases in the amount of basal glide that can be sustained prior to fracture have been observed in crystals purified by zone-refining. In each case, eventual fracture was by sharp basal cleavage, suggesting that the split-bend plane model still applies to the fracture of beryllium of reasonably high purity. Calculations are made to show to what extent basal ductility can be increased by purification while the split bend-plane fracture process remains applicable. Experimentally observed ductilities are generally somewhat lower than those predicted by calculation because of premature failure due to defects introduced during specimen preparation and testing. (auth)

5774 (DMIC-189) THE ENGINEERING PROPERTIES OF TANTALUM AND TANTALUM ALLOYS. F. F. Schmidt and H. R. Ogden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 13, 1963. Contract AF33(616)-7747. 112p.

Results of a state-of-the-art survey covering tantalum and seven of its alloys are presented. All data are given in tabular and graphical form covering some of the more important physical, mechanical, and metallurgical properties for each material. References are given at the conclusion of each material section. (auth)

5775 (HW-79081) AN EVALUATION OF WROUGHT 430 BORON STAINLESS STEEL. R. K. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 30, 1963. Contract [AT(45-1)-1350]. 4p.

A program was conducted to develop 430 stainless steel with 1.5% ferroboron for use as balls in the NPR safety system. B^{10} was added along with the 1.5% ferroboron, resulting in an overall blackness of 2.0% natural boron equivalent. The following tests were conducted on 430-B and 304-B for comparison: machinability, welding, tensile, and hardness. (D.L.C.)

5776 (IITRI-B6005-11) RESEARCH DESIGN TO EVALUATE Zr–2.5Nb AND Zr–2.5Nb–0.5Cu ALLOYS FOR DELAYED FAILURE HYDROGEN EMBRITTLEMENT. Final Report, October 15, 1962–October 14, 1963. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Nov. 14, 1963. Contract AT(11-1)-578. 50p.

In a previous program, the existence of moderate delayed failure of Zr–2.5Nb with 500 ppm absorbed hydrogen was established. The present investigation is to determine static fatigue susceptibility of this alloy under various conditions of hydrogen content, heat treatment, and metallurgical condition and includes study of the ternary modification Zr–2.5Nb–0.5Cu. Notched and unnotched specimens were evaluated under static loading conditions, primarily at room temperature and with 500 ppm absorbed hydrogen, and the time to failure and fracture characteristics were determined. The metallurgical history which resulted in significant delayed failure susceptibility consisted of water quenching followed by an aging treatment which gave a matrix of entirely transformed beta. If an alpha-transformed beta microstructure was produced, static fatigue was markedly attenuated. The results can be accounted for by consideration of whether a crack nucleus can propagate through the matrix or be stopped by local plastic yielding. The propagation of cracks is therefore determined by matrix strength and ductility, which appear to be strong factors in determining hydrogen embrittlement. (auth)

5777 (NMI-9516(Vol.I)) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. S. H. Gelles (Nuclear Metals, Inc., Concord, Mass.). June 1962. Contract AF33(616)-7065. 225p. (AD-290493; ASD-TDR-62-509 (Vol. I))

Work conducted on beryllium research and development is described. Two programs deal with the purification and evaluation of purified beryllium. It was found that high-purity beryllium could be produced by a vacuum distillation process. Preparation of pure metal by decomposition of the iodide did not appear to be feasible. Four programs deal with the joining of beryllium. The feasibility of joining beryllium by ultrasonic welding was shown. The resistance spot welding program led to definition of the welding parameters, and to methods of altering the weld nugget structure and of eliminating cracking and porosity. The application of warm working in the form of roll-planishing improved to some extent the mechanical behavior of welds made by the tungsten-arc inert gas (TIG) process. In the brazing effort, the optimum time and temperature for brazing beryllium with silver was defined and the effects of post-braze heat treatment on the room temperature and elevated temperature mechanical properties were determined. The remaining programs deal with the flow and fracture characteristics of beryllium and the effect of impurities and alloying additions. Heat-treatment of commercially pure beryllium was found to alter the mechanical properties. These changes were shown to be due to the precipitation of a fcc compound having a lattice parameter $a_0 = 6.07$ Å. This ap-

pears to be associated with a precipitation reaction involving Fe and possibly Si and Al. The occurrence of a yield point in beryllium was shown to be consistent with the locking of dislocations by impurities. Techniques for determining the distribution of beryllium oxides and voids in beryllium by replication electron metallography were improved and the morphology of oxide layers artificially introduced between pressure-bonded beryllium discs under different conditions were studied. Many very fine precipitate particles were found, by transmission electron microscopy, to be present in commercially pure beryllium. These particles appeared to affect the movement of dislocations. Dislocation structures associated with "bend plane" formation were also found. Twinning was found to be one of the major factors contributing to surface damage in beryllium. Cracks were found to be a relatively minor factor. Inclusions were found to play a role in the initiation of cracks. A low reduction rolling process was developed that produced sheet having three dimensional ductility superior to high reduction rolled sheet and equivalent tensile properties. A Be–1 wt % Cu alloy showed uniaxial properties superior to unalloyed Be but somewhat lower three-dimensional properties. (auth)

5778 (NMI-9516(Vol.II)) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. S. H. Gelles (Nuclear Metals, Inc., Concord, Mass.). Sept. 1962. Contract AF33(616)-7065. 223p. (AD-406872)

5779 (NP-13403) ENGINEERING PROPERTIES OF POTASSIUM AND CESIUM. Quarterly Report No. 12, July 1–September 30, 1963. Alexis W. Lemmon, Jr. (Battelle Memorial Inst., Columbus, Ohio). Oct. 30, 1963. Contract NAS 5-584. 8p.

Many of the thermodynamic and transport properties of potassium, both liquid and vapor, were measured at 900 to 2100°F. Experimental values for vapor pressure, specific heat of liquid, thermal conductivity of liquid, viscosity of liquid, and P-V-T characteristics were obtained. Currently the experimental program for measuring the thermal conductivity of potassium vapor is in progress. Experimental techniques for the direct measurement of the specific heat of potassium and for the measurement of the viscosity of the vapor were of interest. The latent heat of vaporization, enthalpy, entropy, and specific heat of potassium vapor were computed from some of the data obtained. Just being started are measurements of the enthalpy, viscosity, and thermal conductivity of cesium liquid. The thermal conductivity of cesium vapor also will be determined. (auth)

5780 (NP-13429) PREPARATION AND EVALUATION OF HIGH-PURITY BERYLLIUM. Quarterly Progress Report, July 15, 1963–October 14, 1963. G. E. Spangler, M. Herman, D. B. Hoover, and V. V. Damiano (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOw 63-0500-d. 37p. (Q-B2089-3)

Hot-swaging schedules for zone-refined Be were developed for producing sound fine-grained structures. The recovery, recrystallization, and grain growth characteristics of hot-swaged Be were studied for the zone-refined Be, SR grade Pechiney Be, and commercial grade Berylco Be. Wire bend tests on hot-swaged zone-refined Be exhibited considerable ductility. Electron transmission microscopic studies were made of dislocation structures in strained Be crystals; etching artifacts and very fine precipitates were observed. (D.L.C.)

5781 (SRB-63-3) ABNORMAL GRAIN GROWTH IN ALUMINUM AND ITS ALLOYS: AN ANNOTATED BIBLIOGRAPHY. Charles G. Gros, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). June 1963. 15p.

Thirty-seven references on abnormal grain growth in aluminum and its alloys in the field of critical straining and thermal treatment are presented. Material on the prevention of such growth by "seeding" aluminum alloys with intermetallics is included, as is material on other prevention techniques. The period covered is from 1950 through May 1963. (auth)

5782 (TID-19812) THE TRUE STRESS-STRAIN PROPERTIES OF BRITTLE MATERIALS TO VERY HIGH TEMPERATURES. Final Report, 1962–1963. (Southern Research Inst., Birmingham, Ala.). Contract AT(40-1)-2694. 96p.

The improvement of the gas-bearing system continued and the capabilities of the over-all facility for determination of stress-strain properties were extended. Several parametric studies in uniform tension were completed and an investigation of the volume theory of failure for brittle materials was initiated. A 6500°F radiant heating source was developed and the initial runs to evaluate the furnace proved extremely successful. A temperature of 6510°F was achieved on the first run made under pressurization. A vapor-deposited graphite was obtained on the first run in the vicinity of 6000°F. The 6500°F furnace provides radiant heat-soaking of materials to 6500°F to permit the exploration of the effect of extremely elevated temperatures on graphitization, dislocations, and structure. Work is continuing to incorporate the heating source in the existing equipment to permit the determination of thermal and mechanical properties in this temperature range. The effects of temperature, surface finish, strain rate, and size on the tensile properties of ATJ graphite and alumina were investigated. The study demonstrated the ability of the gas-bearing system to provide uniform fields of tensile stress, to eliminate the influence of test apparatus variations from the data, and, therefore, to permit the investigation of parameters whose effect on the ultimate tensile strength may be relatively small or masked by other conditions. Based upon the data obtained with the gas-bearing system, a discussion of the applicability of Weibull's theory of volume effect is presented. The degree of the effect of flaw distribution in brittle materials is questioned. Experimental data, obtained for 1-in. diameter specimens of ATJ graphite, indicated a significantly higher value of ultimate tensile strength at that volume than that predicted by the volume theory. (auth)

5783 (TRG-Report-564) SOME CAUSES OF BRITTLENESS IN CHROMIUM–NICKEL AUSTENITIC STAINLESS STEELS. A literature Survey. M. Farrow (United Kingdom Atomic Energy Authority. Reactor Group, Culcheth, Lancs, England). May 22, 1963. 24p. (NPCC-FEWP(63)/P-122)

In this survey an attempt was made to collect evidence on two possible causes of brittleness in austenitic stainless steels, namely; the parts played by sigma phase and chromium carbide precipitations. The general circumstances under which each of the above precipitates occur were studied. Additional alloy element effects were reviewed and methods of preventing or controlling the formation of carbide and sigma phase are discussed. (auth)

5784 DOMAIN PATTERNS IN COLUMBIUM (NIOBIUM). J. Van Landuyt and S. Amelinckx (CEN, Mol, Belg.) Appl. Phys. Letters, 4: 15-17(Jan. 1, 1964).

Striking domain patterns were observed at room temperature during transmission electron microscopy of cold-rolled foils of zone-refined Nb annealed at 1300°C in a vacuum of 10^{-5} torr and then electropolished. After observations of the patterns, it is concluded that the Nb lattice must be dis-

torted, the boundary separating two regions whose axes of distortion are along different directions. (R.E.U.)

5785 APPARATUS FOR MEASUREMENT OF THERMAL CONDUCTIVITY OF NUCLEAR CERAMICS. Z. Mihailovic (Commissariat a l'Energie Atomique, Saclay, France). Ber. Deut. Keram. Ges., 39: 385-6(July 1962). (In German)

A description is given of three systems intended for the measurement of the thermal conductivity of nuclear and industrial ceramics. The coefficient of thermal conductivity, k, is obtained by a steady state comparative method using Armco iron as a thermal conductivity standard. The measurements are performed at temperatures ranging from 80 to 1500°C. (auth)

5786 CONTRIBUTION ON THE POLYMORPHIC CONVERSION OF PURE ZIRCONIA. R. Cypres, R. Wollast, and J. Raucq (Rhein.-Westf. Technische Hochschule, Aachen). Ber. Deut. Keram. Ges., 40: 527-32(Sept. 1963). (In German)

Conditions were investigated under which the tetragonal low-temperature modification of ZrO_2 is stable. Pure $Zr(OH)_4$ was subjected to a thermal breakdown and the formation of ZrO_2 up to 1200°C was studied by DTA, thermogravimetry, electrical conductivity, infra-red absorption, and x-ray diffraction. All the investigations showed that at low temperatures tetragonal ZrO_2 is stable if its lattice is stabilized by foreign ions, particularly by OH^- if the initial material is $Zr(OH)_4$ or SO_4^{2-} if the initial material is $Zr(SO_4)_2$. At 400°C amorphous ZrO_2 crystallizes into tetragonal zirconia. From 500°C this material converts continuously into monoclinic zirconia; owing to the slow escape of water from $Zr(OH)_4$, this process is accompanied by a loss in weight. The conversion is completed at 800°C and is irreversible. The monoclinic form is the only form of pure zirconia stable at ordinary temperatures. The measurements carried out confirm previous observations that the transition monoclinic → tetragonal occurs not at some definite temperature, but during an interval of 100°C depending on the previous history of the material. By measuring the electrical conductivity it is possible to show a hysteresis in the reversible conversion of the tetragonal high-temperature modification into a monoclinic structure. Above 1150°C the tetragonal form is stable. The characteristic lines of this modification were determined with the aid of a high-temperature x-ray camera. The tetragonal low-temperature lattice of zirconia shows a slight widening of the equidistant interplanar spacings as compared to such spacings in the tetragonal lattice determined at 1200°C. This widening is explained by the presence of foreign ions in the unstable tetragonal ZrO_2 lattice. When, after heating to 1200°C, the specimens were cooled, the tetragonal structure could be observed in no single case. Specimens that were heated to 1500°C and then quenched in mercury showed a complete conversion into monoclinic zirconia. (auth)

5787 APPLICATION OF THE PETCH RELATION TO α URANIUM: INFLUENCE OF GRAIN SIZE ON PLASTIC DEFORMATION. André Lemogne, Jean Morin, and Paul Lacombe (Centre de Recherches Métallurgiques de l'École des Mines, Paris). Compt. Rend., 257: 3170-3 (Nov. 18, 1963). (In French)

An attempt is made to determine whether the law of Petch is applicable under the constraints of plastic flow and of rupture in αU. U of two very different purities are studied, and are found to follow to a good approximation the Petch relation $\sigma = \sigma_0 + kd^{-\frac{1}{2}}$. (tr-auth)

5788 NUCLEAR SPECIFIC HEAT OF AN ALLOY OF PRASEODYMIUM AND GADOLINIUM. Bernard Dreyfus, Albert Lacaze, and Jean-Claude Michel (CEN, Grenoble, France). Compt. Rend., 257: 3355-7(Nov. 25, 1963). (In French)

The specific heat of Gd–27 at.% Pr alloy is measured at 1.3 to 4°K. The nuclear hyperfine coupling is determined by the approach of the Schottky anomaly in AT^{-2}. The coefficient A, reduced to 1 mole of Pr, is found to be 850 mJ·°K/mole, as compared with the value of 20 mJ·°K/mole for pure Pr. (tr-auth)

5789 ON THE BINARY SYSTEM URANIUM–URANIUM DIOXIDE. Pierre L. Blum, Philippe Guinet, and Henri Vaugoyeau (CEN, Grenoble, France). Compt. Rend., 257: 3401-3(Nov. 25, 1963). (In French)

The liquidus curve of the system U–UO_2 is determined by the saturation method. The solidus curve is determined by differential thermal analysis. The diagram is of the form of an eutectic at 100% U, and a peak (inferred from extrapolation) at 100% UO_2. (tr-auth)

5790 A COMPARISON OF THE ELASTIC CONSTANTS OF CHROMIUM AS DETERMINED FROM DIFFUSE X-RAY AND ULTRASONIC TECHNIQUES. Ali Sumer and J. F. Smith (Ames Lab., Ames, Iowa). J. Appl. Phys., 34: 2691-4(Sept. 1963). (IS-643)

The elastic constants of the same single crystal of chromium were determined by both ultrasonic pulse-echo and thermal diffuse x-ray techniques. The difference between the numerical results of the two sets of measurements is primarily attributable to the limited precision which attends the measurement of diffuse x-ray intensities. Any additional factors which may contribute to the difference are masked by the precision. If suitable single crystals can be prepared, the ultrasonic technique is much to be preferred. (auth)

5791 CsCl-TYPE COMPOUNDS IN BINARY ALLOYS OF RARE-EARTH METALS WITH ZINC AND COPPER. C. C. Chao, H. L. Luo, and P. Duwez (California Inst. of Tech., Pasadena). J. Appl. Phys., 35: 257-8(Jan. 1964).

The CsCl-type structure was reported in alloys of Cu with Sm, Tb, Dy, Ho, and Tm and in alloys of Zn with Y, Nd, Sm, Gd, Tb, Dy, Ho, Er, and Tm. The structures of the alloys were investigated by x-ray diffraction, and it is shown that a linear relation exists between the lattice parameter of the compounds and the trivalent radii of the rare-earth elements. (C.E.S.)

5792 THERMODYNAMICS OF FORMATION OF $ThMg_2$. D. B. Novotny and J. F. Smith (Ames Lab., Ames, Iowa). J. Inst. Metals, 92: 122(Dec. 1963).

The thermodynamic functions associated with the formation of $ThMg_2$ were determined by measuring the equilibrium vapor pressure of magnesium over the two-phase alloys. Data indicated that for the reaction $2Mg(g) + Th(s) \rightleftharpoons ThMg_2(s)$ the equilibrium vapor pressure may be represented as $\log_{10}P(\text{mm Hg}) = (-9130 \pm 210)/(T) + (10.3 \pm 0.3)$. The vapor pressure relationship of this equation may be combined with the vapor pressure data for pure solid magnesium to obtain the following free energy, in kcal per mole of compound, for the formation of $ThMg_2$ from the pure solid elements: $\Delta F^0 = -14.3 \pm 3.1 + (15.2 \pm 4.3) \times 10^{-3}$ T. (M.C.G.)

5793 FISSION PRODUCT EFFECTS IN URANIUM DIOXIDE. B. G. Childs (United Kingdom Atomic Energy Authority, Thurso, Caithness, Scotland). J. Nucl. Mater., 9: 217-44(Aug. 1963).

The physical behavior of fission product impurities in irradiated uranium dioxide fuel is reviewed under two main headings, which are: the processes and kinetics governing the escape of fission products from uranium dioxide, both

during irradiation, and also on subsequent out-of-pile heating; and the physical and microstructural changes produced by the fission products retained in the fuel. In many areas of the subject the experimental data are limited or contradictory and no final conclusions are possible. Some experiments to rectify the situation are suggested. (auth)

5794 THE RELATIVE CONTRIBUTIONS OF DISPERSION AND SOLUTION STRENGTHENING IN Zr–Sn–Nb ALLOYS. D. L. Douglass (General Electric Co., Pleasanton, Calif.). J. Nucl. Mater., 9: 252-60(Aug. 1963).

Dispersion strengthening by Zr_4Sn in a matrix of constant composition in the Zr–Nb–Sn system was considerably greater than solution strengthening by either niobium or tin. Niobium was more effective than tin in solution hardening, although, the results could not be analyzed by any of the existing theories of solution strengthening. The best agreement of the dispersion strengthening data was obtained with the Gensamer hypothesis, which predicts a linear relationship between yield stress and the negative logarithm of the interparticle spacing. Fair agreement was also achieved with the Lenel-Ansell theory, although it was shown that the agreement was fortuitous. It was concluded that a combination of both solution and dispersion strengthening can result in considerable improvement in zirconium alloys and can provide a basis of strengthening weak, corrosion resistant alloys. (auth)

5795 THE URANIUM–OSMIUM SYSTEM. A. G. Knapton (Associated Electrical Industries, Aldermaston, Berks, Eng.). J. Nucl. Mater., 9: 309-19(Aug. 1963).

The uranium–osmium system was investigated over the whole range of compositions. The principal features of the system are the high solubility of osmium in γ uranium and the existence of four intermetallic compounds: U_3Os, U_2Os, U_5Os_4, and UOs_2. (auth)

5796 HYDROGEN EMBRITTLEMENT OF STEEL PRESSURE VESSELS IN PRESSURISED WATER REACTOR SYSTEMS. D. R. Harries and G. H. Broomfield (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 9: 327-38(Aug. 1963).

The possible sources of hydrogen in pressurized water reactor systems are considered in relation to the possible embrittlement of unclad ferritic steel pressure vessels. It was concluded that the only significant source of hydrogen is that due to the corrosion reaction at the steel-water interface. The hydrogen concentrations at the inner surfaces of the steel vessels and the equivalent hydrogen pressures were calculated for pressure vessels operating at 250, 280, and 315°C, respectively and ranging in thickness from 0.5 to 10 in. (1.2–25 cm), assuming a pessimistic corrosion rate of 75 mg/dm^2 × month and that all the corrosion-induced hydrogen enters the steel. The existing information on the effects of hydrogen in iron and steel and considerations of the possible effects of irradiation suggest that low alloy steels will be immune to hydrogen embrittlement in pressurized water reactor systems. However, plain carbon steels in the form of thick pressure vessels might well be embrittled under similar conditions. (auth)

5797 ZIRCONIUM HYDRIDE FORMATION IN A BINARY MAGNESIUM–ZIRCONIUM ALLOY. J. E. Harris, P. G. Partridge, W. T. Eeles, and G. K. Rickards (Central Electricity Generating Board, Berkeley, Gloschester, Eng.). J. Nucl. Mater., 9: 339-47(Aug. 1963).

The structure of a magnesium/0.6 wt% zirconium alloy was studied before and after hydrogenation. In the as-worked form most of the zirconium was in solid solution but occasionally α–zirconium particles were found within the stringers. Heat treatment in moist argon at 570°C resulted in the formation of ε–zirconium hydride. The precipitates, which frequently had an associated strain field, lay in the basal plane of the matrix with edges parallel to $(1\bar{1}20)$. In one set of orientations there was good crystallographic matching between the major faces of the precipitates and the matrix basal planes. Precipitates also occurred at the grain boundaries where they were found to inhibit boundary migration. The results are discussed in relation to the possible behavior of a magnesium–zirconium alloy can during its life in a reactor. (auth)

5798 MIXED OXIDE SYSTEMS OF LANTHANIDE AND ACTINIDE ELEMENTS. I. ROENTGEN STUDY OF THE SYSTEM URANIUM OXIDE–EUROPIUM OXIDE. H. Haug and F. Weigel (Universität, Munich). J. Nucl. Mater., 9: 355-9(Aug. 1963). (In German)

The lattice parameters of mixed oxide samples of known uranium/europium ratio were determined to a high precision. From the appearance of the powder diffraction photographs and the variation of the lattice constants as a function of composition, conclusions were drawn concerning the phase structure of the system uranium oxide/europium oxide. In the range 38–64 mole % $EuO_{1,5}$ a fluorite phase appears, the parameter of which falls linearly from 5.406_5 to 5.391_0 Å. On the uranium-rich side of the system, mixed crystals of fluorite/type were found side by side with orthorhombic $UO_{2,6}$. On the europium-rich side the fluorite-type phase continues with strongly distorted lattice and steeply increasing parameter. The transition to the C-type of Eu_2O_3 is not observed until the $EuO_{1,5}$ content exceeds 90 mole %. The lattice constant of the fluorite-type phase when extrapolated to 100 mole % $EuO_{1,5}$ fits into a linear relationship shared for all mixed oxide systems containing the oxides of the light lanthanides together with uranium oxide. (auth)

5799 MIXED OXIDE SYSTEMS OF LANTHANIDE AND ACTINIDE ELEMENTS. II. ROENTGEN STUDY OF THE SYSTEM PLUTONIUM OXIDE–EUROPIUM OXIDE. H. Haug and F. Weigel (Universität, Munich). J. Nucl. Mater., 9: 360-3(Aug. 1963). (In German)

The lattice parameters of mixed oxide samples of known plutonium and europium contents were determined to a high precision. In the plutonium oxide/europium oxide system a fluorite phase appears in the range 0–42 mole % $EuO_{1,5}$. From 0–15 mole % $EuO_{1,5}$, the lattice parameter of PuO_2 is scarcely affected, while further additions of Eu_2O_3, in the range 15–42 mole % $EuO_{1,5}$, cause the parameter to increase. This kink in the parameter/composition plot is interpreted in terms of an oxidation of plutonium to a valency >4, enforced by the incorporation of Eu^{3+} in the fluorite lattice. With europium contents above 42 mole % $EuO_{1,5}$ a fluorite phase with considerable lattice distortion appears, while above 60 mole % $EuO_{1,5}$ the transition to the C-type of Eu_2O_3 is found. (auth)

5800 THE HEAT OF TRANSPORT OF HYDROGEN IN ZIRCONIUM ALLOYS. A. Sawatzky (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 9: 364(Aug. 1963).

The heat of transport of hydrogen was measured in several Zr alloys considered for use in reactors. It was concluded that small quantities of Nb or Y added to Zr have a negligible effect on the heat of transport, which is 5.7 ± 0.5 kcal/mole for all alloys tested. (P.C.H.)

5801 THE $(\beta + \gamma)/\gamma$ PHASE BOUNDARIES AT 675°, 700° AND 720°C IN THE URANIUM-RICH CORNER OF THE U–Mo–Nb DIAGRAM. E. F. Tate and S. Nicholson (International Research and Development Co., Ltd.,

Newcastle-upon-Tyne, Eng.). J. Nucl. Mater., 9: 365-6 (Aug. 1963).

U–Mo–Nb alloys were examined after water-quenching from 675, 700, and 720°C to determine the phases present. The shape of the $(\beta + \gamma)/\gamma$ boundaries is in line with the finding that an increased γ/β ratio can be obtained by step-annealing (675–700°C) alloys whose compositions lie on the line joining U-3.6 at.% Mo and U-6.9 at.% Nb, as the Nb content is progressively increased. (P.C.H.)

5802 A THERMODYNAMIC STUDY OF THE TUNGSTEN–OXYGEN SYSTEM AT HIGH TEMPERATURES. R. J. Ackermann and E. G. Rauh (Argonne National Lab., Ill.). J. Phys. Chem., 67: 2596-2601 (Dec. 1963).

The sublimation behavior of the tungsten–oxygen system was investigated over the temperature range 1300 to 1600°K by means of mass effusion studies, mass spectrometric observations, chemical analyses, and x-ray diffraction examination of the condensed phases. Measurements were carried out on compositions ranging from $WO_{1.89}$ to WO_3. In all cases the thermodynamically important vapor species are W_4O_{12}, W_3O_9, W_3O_8, and W_2O_6. Univariant behavior was observed for the solid phases $W - WO_2$, $WO_2 - W_{18}O_{49}$, $W_{18}O_{49} - W_{20}O_{58}$, $W_{20}O_{58} - WO_{2.96}$, and $WO_{2.96}$. The composition $WO_{2.96}$ probably represents the azeotropic composition of the WO_{3-x} solid solution produced by the vacuum and is the only single phase that evaporates congruently below 1550°K. Except for the $W_{20}O_{58} - WO_{2.96}$ mixture in which the composition of the vapor phase is between those of the solid phases, all other phases and mixtures of two solid phases evaporate incongruently, since the vapor phase is richer in oxygen than the condensed phase. Above 1550°K there are no congruently evaporating compositions. Standard free energies, enthalpies, and entropies of formation for the four major vapor species and for the $W_{18}O_{49}$, $W_{20}O_{58}$, and $WO_{2.96}$ solid phases are given. (auth)

5803 THE ORGEL PROJECT. J. C. Leny. Neue Tech., 5: 585-96(Oct. 1963). (In French)

ORGEL (acronym for ORganique–Eau Lourde, or heavy-water-moderated and organic-cooled) is a developmental program for electric-power-producing plants. The ORGEL concept is outlined. A 250-Mwe ORGEL-type power plant is described, as are a critical experiment and a reactor test assembly. Problems associated with the choice of fuel element and coolant are discussed. (T.F.H.)

5804 MAGNETIZATION OF CUBIC LAVES PHASE COMPOUNDS OF RARE EARTHS WITH COBALT. J. W. Ross and J. Crangle (Univ. of Sheffield, Eng.). Phys. Rev., 133: A509-10(Jan. 20, 1964).

Rare-earth compounds with cobalt are strongly magnetic. For the heavier rare earths, the gross magnetic moment appears to arise from opposed alignment of the rare earth and the cobalt atoms. If the rare earths are assumed to have characteristic localized magnetic moments Jg, the moments on the cobalt atoms are about $1.7\mu_B$ in the Tb, Dy, Ho, and Er compounds, a little less in the Gd compound, and zero in the Pr, Nd, and Sm compounds. The basic coupling mechanism is that of indirect exchange through the conduction electrons between rare-earth spins. (auth)

5805 INVESTIGATION OF THE NIOBIUM–OXYGEN SYSTEM. II. SOLUTION OF OXYGEN IN NIOBIUM AND PRECIPITATION OF OXIDE FROM SUPERSATURATED MIXED CRYSTALS. Erich Gebhardt and Rolf Rothenbacher (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 54: 623-30(Nov. 1963). (In German)

The solubility limit of oxygen in niobium between 500 and 1900°C was determined by measurement of electrical conductivity, microhardness, and lattice parameter. The results showed, that the concentration of saturation is temperature dependent. It increases from 1.1 at.% O at 750°C to 5.5 at.% O at 1540°C. In this temperature range it can be described by the equation $\ln c_{max} = 3.829 - 7700/RT$ (c_{max} in at.% O). There were considerable deviations from this relation above 1540 and below 750°C. It can be assumed, that the deviations above 1540°C are partially caused by degassing of the niobium samples and partially by instability of the highly supersaturated α-solid solution during quenching. The deviations, which were found between 750 and 500°C were due to the effect, that no complete equilibrium between oxide and α-solid solution was reached. In the range of the temperature dependent solubility of α-solid solutions experiments were conducted on precipitation of oxides from homogeneous supersaturated niobium–oxygen solid solutions, which were obtained by quenching. Quenching temperature was 1460°C, the aging temperatures were between 1000 and 500°C. Metallographic and x-ray investigations showed that the nature of the oxide precipitation depends on the aging temperature. At aging temperatures between 1000 and 800°C precipitation of NbO occurred only on grain boundaries. Between 700 and 500°C particles were found in addition in the interior of the grains. Some of these particles showed a crystallographic habit. Below 550°C plate shaped particles of NbO_2 were found. This phase has a crystallographic habit and can be distinguished by polarized light. The simultaneous formation of several oxide phases indicates, that there is no equilibrium at lower aging temperatures and that some of the observed oxides are metastable phases. (auth)

5806 SOME MAGNETIC PROPERTIES OF A GADOLINIUM SINGLE CRYSTAL. V. I. Chechernikov, Iuliu Pop, I. V. Burov, and E. M. Savitskii (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 867-9(Oct. 1963). (In Russian)

The magnetic properties of a single crystal of gadolinium are measured from 20 to 1000°C. The magnetic susceptibility measured in a direction perpendicular to the axis c is greater than that in the parallel direction. Magnetization curves are measured in both directions near the magnetic transformation temperature (17°C). A critical field H_K = 3000 Oe is found at which the magnetization sharply increases. With increase of temperature the magnitude of the magnetization jump decreases and disappears at T = 100°C. The data indicate the existence of a complex spin configuration in gadolinium. (auth)

5807 MEASUREMENT OF THERMAL RADIATION PROPERTIES OF SOLIDS. A Symposium held at Dayton, Ohio, September 5, 6, 7, 1962. Joseph C. Richmond, ed. Washington, D. C., National Aeronautics and Space Administration, 1963. 593p. (NASA SP-31). $3.50(GPO).

Fifty-seven articles are included; separate abstracts were prepared for three. The remaining fifty-four articles not abstracted in NSA include information on techniques for and measurement of thermal radiation properties of solids at 0 to 200°K, 200 to 450°K, 450 to 1400°K, and above 1400°K. (P.C.H.)

For abstracts of individual papers see: 5808, 5809, and 5981.

5808 THE MEASUREMENT OF TOTAL NORMAL EMITTANCE OF THREE NUCLEAR REACTOR MATERIALS. T. Limperis, D. M. Szeles, and W. L. Wolfe

(Univ. of Michigan, Ann Arbor). p.357-64 of "Measurement of Thermal Radiation Properties of Solids." Washington, D. C., National Aeronautics and Space Administration, 1963.

The total normal emittance of 304 stainless steel, A-7 carbon steel, and borated graphite, which are used in the Enrico Fermi nuclear reactor, was determined at 600 to 950°K in 25°K steps. The experimental procedure is outlined. (P.C.H.)

5809 THE TOTAL HEMISPHERICAL EMITTANCE OF PLATINUM, COLUMBIUM-1% ZIRCONIUM, AND POLISHED AND OXIDIZED INOR-8 IN THE RANGE 100° TO 1200°C. D. L. McElroy and T. G. Kollie (Oak Ridge National Lab., Tenn.). p.365-79 of "Measurement of Thermal Radiation Properties of Solids." Washington, D. C., National Aeronautics and Space Administration, 1963.

Equipment was developed for measuring the temperature dependence of the total hemispherical emittance (E_t:T) of metal and alloy strips to 1200°C using direct heating in a constant-temperature, blackbody vacuum chamber. Precise specimen dimensions and thermocouple positioning are requisite to the method and the techniques developed to accomplish these are described. If the systematic errors of the equipment are evaluated, the E_t measurement accuracy is ±2.7% and the reproducibility is ±0.5%. Experimental measurements on platinum (Pt), niobium–1% zirconium (Nb–1% Zr), and Inor-8 strips illustrated effects that cause changes in E_t. Increased E_t:T occurred with increasing surface roughness and oxidation. Results are presented that show the effects of specimen reaction with the measuring environment and specimen-oxide reactions. The electrical resistivity of the specimen was obtained from the data taken in an E_t determination. A change in the electrical resistivity of Inor-8 occurs between 400 and 600°C and is accompanied by a corresponding change in E_t:T. Finally, the applicability of the method for determining E_t:T on a cylindrical specimen was demonstrated. (auth)

5810 X-RAY STUDIES OF MATERIALS. A. Guinier and D. L. Dexter, eds. Interscience Tracts on Physics and Astronomy, Number 20. New York, Interscience Publishers, 1963. 164p. $6.75.

An elementary treatment is presented of the current use and techniques of x rays in studies of the structure of matter. Traditional techniques are reviewed, and the present state of the art is described. Among the techniques described are radiography, diffraction, and spectroscopy. (D.L.C.)

Radiation Effects

5811 (ANL-6651) SWELLING OF ALUMINUM-CLAD ALUMINUM–PLUTONIUM ALLOYS ON POSTIRRADIATION ANNEALING. Final Report. B. A. Loomis (Argonne National Lab., Ill.). Nov. 1963. Contract W-31-109-eng-38. 10p.

The changes in density and hardness as a result of annealing at temperatures up to 600°C are reported for an aluminum-clad Al-5 wt % Pu and Al-10 wt % Pu alloy in which 89.3% and 75.6%, respectively, of the plutonium atoms were fissioned. The density of the irradiated specimens at room temperature decreased after pulse anneals of 15-min duration at temperatures above 525°C, whereas for lower annealing temperatures the density of the specimens increased. The hardness of the specimens at room temperature decreased substantially after annealing at temperatures between 275°C and 360°C. A specimen of 1100 aluminum which was heavily deformed by rolling was also annealed in a manner similar to the irradiated materials. The density of the aluminum at room temperature increased after pulse anneals at temperatures up to 600°C, and the hardness decreased after annealing at temperatures above 300°C. (auth)

5812 (ANL-6665) IRRADIATION AND POSTIRRADIATION ANNEALING OF SOME ALUMINUM-BASE FUELS. C. F. Reinke (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 39p.

Irradiated specimens of 39 wt % U_3O_8 dispersed in aluminum and of aluminum-17.3 wt % uranium alloy were annealed. Each specimen was partially clad with aluminum. Gross swelling was not observed for the aluminum-39 wt % U_3O_8 dispersion specimens for burnup and annealing temperature levels ranging up to 1.0×10^{20} fissions per cc and 550°C, respectively. Small volume increases were found, however, and these were attributed to the aluminum reduction of U_3O_8, which is accompanied by measurable volume increases. X-ray diffraction analyses confirmed the reaction between the U_3O_8 and the aluminum matrix. The dispersion specimens and, in particular, the U_3O_8 particles sintered during irradiation at temperatures from 55 to 90°C in an effective thermal-neutron flux of between 1 and 3×10^{13} nv. Annealing at 550°C produced severe localized blistering on specimens of aluminum-17.3 wt % uranium alloy having burnups of 5.9×10^{20} fissions per cc. Similar conditions produced only a small uniform volume increase when the burnup was 1.4×10^{20} fissions per cc. The observed stability is attributed to a defect structure in the compound UAl_4 in which unoccupied uranium sites trap fission products and, in particular, fission product gases. (auth)

5813 (ANL-6678) PRELIMINARY IRRADIATIONS OF PuC AND UC–PuC. J. H. Kittel, L. A. Neimark, R. Carlander, O. L. Kruger, and R. C. Lied (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 15p.

Preliminary irradiations were made of arc-cast specimens of PuC and UC-PuC and of pressed and sintered pellets of UC–PuC to determine the suitability of these materials for further development as possible fuels for liquid metal-cooled fast reactors. The PuC content in the mixed-carbide specimens was near 20 wt %. The specimens were irradiated as fuel rods in the fast reactor EBR-I. Maximum fuel burnup and temperature during irradiation were respectively 0.10 metal atom percent and 650°C. The cast PuC specimens were found to have fractured to a greater extent under irradiation than did the cast mixed-carbide specimens. Dimensional changes in those specimens which did not fracture were negligible. Fission gas release from the cast specimens was 0.24% of the theoretical yield. The pressed and sintered pellets did not fracture under irradiation and showed negligible dimensional changes. Fission gas release from the pellets was 12.0% of theoretical. The high gas release from the pressed and sintered specimens is attributed to a relatively high degree of open porosity which existed in the pellets. (auth)

5814 (CONF-331-2) THE INFLUENCE OF FINELY DISPERSED PRECIPITATES ON FISSION GAS BUBBLE FORMATION IN URANIUM–MOLYBDENUM TERNARY ALLOYS. D. Kramer, W. V. Johnston, and C. G. Rhodes (North American Aviation, Inc. Science Center, Canoga Park, Calif.). [1963]. Contract [AT(11-1)-Gen-8]. 43p.

From the Metallurgical Society of American Institute of Mechanical Engineers Annual Meeting, Dallas, Feb. 1963.

An irradiation experiment was conducted to test the ef-

fectiveness of finely dispersed phases in reducing swelling. U–4% Mo–0.1% Si and U–10% Mo–0.04% Sn alloys containing finely dispersed phases were irradiated with appropriate control samples at low temperatures, then post-irradiation annealed to induce swelling. The annealing was performed in steps at progressively higher temperatures from 550 to 950°C with density measurements taken after each step and electron microscope examinations when warranted. The lowest density changes took place in samples having the finest dispersions, 10^{12} to 10^{13} particles per cm^3. Binary control samples having no dispersions experienced density decreases more than ten times that of equivalent samples with dispersions. After a 750°C anneal, a U–4% Mo–0.1% Si alloy with a fine dispersion having experienced a 0.4 at. % burnup showed only a 1.7% density decrease. A U–10% Mo–0.04% Sn alloy showed the same density decrease after an 850°C anneal following a burnup of 0.6 at. %. Irradiation-induced precipitation was observed in the U–4% Mo–0.1% Si alloy and is believed to have occurred in the U–10% Mo–0.04% Sn alloy producing a particle density on the order of 10^{14} per cm^3. The greatly improved swelling resistance of the samples with fine dispersions results from the interaction of gas atoms with the original precipitates and with the radioinduced precipitates. These precipitates, acting as trapping sites for gas bubbles, stabilized the fission gas in an array of a large number of small bubbles thereby reducing the swelling. (auth)

5815 (GA-4742) EFFECT OF NEUTRON IRRADIATION ON MATERIALS SUBJECTED TO MULTIAXIAL STRESS DISTRIBUTIONS. Quarterly Progress Report, July 1–September 30, 1963. T. A. Trozera and P. W. Flynn (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Nov. 6, 1963. Contract AT(04-3)-167. 8p.

Studies are being made to determine the effect of irradiation on tubes subjected to multiaxial stress distribution. A block of A-302B steel was cut, specimens were machined, and irradiation was carried out. Results of tensile, biaxial, and charpy impact test are discussed. Ultimate strength and impact transition temperature shift increased with increasing neutron dose. (M.C.G.)

5816 (NP-13405) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Report No. 11, July–September 1963. (Lockheed-Georgia Co., Marietta, Ga.). Contract NASw-114. 34p. (ER-6590)

Preparation for the in-pile screening program was continued with calibration of thermocouples on instrumented test specimens against a National Bureau of Standards calibrated platinum resistance thermometer, modification of the test loop carriage assemblies, and check out of the test loop transfer cask and cart. Flux measurements were made at various power levels in HB-2 and the results are presented. (auth)

5817 (PAN-438/II) OPTICAL INVESTIGATIONS OF DEFECT ENERGY LEVELS IN n-TYPE GERMANIUM IRRADIATED WITH REACTOR FAST NEUTRONS. S. Ligenza (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1963. 14p.

Quenching of photoconductivity was used to investigate the properties of defect energy levels in n-type germanium irradiated with fast neutrons from a reactor. The quenching curve obtained (quenching vs wavelength of the external illumination) shows distinct maxima and bumps, which can be explained on the basis of the general accepted model of defect energy levels in fast-neutron-irradiated germanium. However, for the first time the distance between the level 0.2 ev, below the conduction band, and the level 0.07 ev, above the valence band, was measured in a direct way. These experiments show also that the quenching effect in neutron irradiated n-type germanium is connected with hole-trapping properties of the defect energy level 0.18 ev above the valence band. (auth)

5818 (USAELRDL-TR-2286) INVESTIGATION FOR POSSIBLE LONG-TERM EFFECTS IN FERRITES FROM HIGH-INTENSITY NEUTRON PULSES. W. W. Malinofsky, J. Newberg, and G. C. Sands (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Sept. 1962. 24p. (AD-400743)

Eleven commercial magnetic ferrite types from two companies were investigated for possible long-term effects due to exposure to neutron irradiation simulating a nuclear burst. That is, the materials were exposed to very high intensity irradiation (approximately 10^{17} $n/cm^2/sec$) for a very short period (a pulse of 80 microseconds at half-height). The exposed samples, as well as controls, were measured for magnetic, crystallographic, and resistivity changes. Specific magnetic properties examined were L, Q, B_m, B_r, and H_c, as well as electrical resistivity. The specific crystallographic properties investigated were lattice-defect production, redistribution of the metal atoms, and changes in lattice symmetry or size. Magnetic and electrical effects due to ambient temperature, etc., were observed in both control and irradiated cores as random changes. In order to isolate these effects from irradiation effects, special control tests were ultimately required. The random nature of the changes necessitated a statistical approach, as well as maximum precision of measurement. The determination of this precision was thus of prime importance. After determining the magnitude of these miscellaneous effects and subtracting them out, it was concluded that no changes were observed caused by the neutron irradiation. (auth)

5819 (UNC-5061) LOW-TEMPERATURE SINTERING OF UO_2: IRRADIATION TESTING. Final Report. N. Fuhrman and R. B. Holden (United Nuclear Corp. Development Div., White Plains, N. Y.). Aug. 30, 1963. Contract AT(30-1)-2374. 27p.

Uranium dioxide pellets prepared by low temperature sintering behave, as far as fuel performance is concerned, like pellets conventionally sintered in hydrogen at high temperatures. The fuel specimen tubes which were, in effect, miniature fuel rods operating in a NaK environment were dimensionally stable at all fuel burnups, which went to 23,000 Mwd/ton U. In the ETR, the calculated pellet surface temperature was approximately 400°C. The fission gas release for the specimen tube irradiated to 15,000 Mwd/ton U burnup was 0.5%, and the release from a control specimen tube containing conventionally sintered UO_2, which was irradiated in the same capsule, showed a release of 0.3%. When irradiated to 23,000 Mwd/ton U at an $\int_{400°C}^{T_c} k(\theta)d\theta$ of 30 w/cm, 4.4% of the fission gas was released. This is consistent with the performance of conventionally sintered UO_2 fuel. Because of its finer grain size, grain growth takes place in low temperature sintered fuel at lower temperatures than in conventionally sintered fuel. No adverse effect is associated with this grain growth, however, and under high performance conditions, conventional UO_2 pellets undergo drastic structural changes which increase the effective thermal conductivity and decrease the central fuel temperatures. This structural change ordinarily occurs at reactor startup when there are essentially no fission products in the fuel, so that it cannot be accompanied by fission

product release. The results of this capsule irradiation program clearly indicate that UO_2 fabricated by low temperature sintering has the same excellent fuel performance capability as conventionally fabricated UO_2. (auth)

5820 SOLAR CELL DEGRADATION UNDER 1-Mev ELECTRON BOMBARDMENT. W. Rosenzweig, H. K. Gummel, and F. M. Smits. Bell System Tech. J., 42: 399-414(Mar. 1963).

The effects of radiation damage on the important parameters of solar cells was evaluated for groups of blue-sensitive n-on-p, normal p-on-n, and blue-sensitive p-on-n cells using 1-Mev electrons. The outer space short circuit current, maximum power, junction characteristic, and spectral response are presented quantitatively as a function of radiation flux along with the bulk minority-carrier diffusion length. The rate of change of inverse squared diffusion length with flux was found to be 1.22×10^{-8} for the p-on-n cells, as compared to 1.7×10^{-10} for the n-on-p. The degradation of the spectral response was consistent with the measured diffusion length for both types of cells if a total effective front layer of 1 μ thickness is assumed for the p-on-n cells. As a result of the less rapid degradation of their minority-carrier lifetime, the n-on-p cells exhibit a greater resistance to radiation than the p-on-n cells. Comparing only the two types of blue-sensitive cells, after prolonged bombardment, the flux ratios required to achieve equal values of short-circuit current and maximum power are 17 and 9.5, respectively. (auth)

5821 RESISTIVITY OF THE ORDERED ALLOY Fe–Ni (50%-50%) UNDER NEUTRON IRRADIATION. André Marchand, Jean Paulevé, and Daniel Dautreppe (CEN, Grenoble, France). Compt. Rend., 257: 2987-9(Nov. 13, 1963). (In French)

By studying the diminution of the electric resistivity during irradiation at decreasing temperatures, an evaluation is made of the critical temperature for the order-disorder transition in the FeNi alloy under consideration. This temperature is determined to be 321 ± 2°C. The study of the kinetics of the establishment of short-range order seems to indicate the predominance of vacancy-interstitial recombination. (tr-auth)

5822 MAGNETIC PROPERTIES OF A NEUTRON-IRRADIATED SINGLE CRYSTAL OF Fe–Ni ALLOY ORDERED IN A MAGNETIC FIELD. Jean Laugier, Jean Paulevé, and René Pauthenet (CEN, Grenoble, France). Compt. Rend., 257: 3340-3(Nov. 25, 1963). (In French)

Single crystals (as well as quadratic crystallites oriented along the three quaternary axes) of Fe–Ni, ordered by application of a magnetic field, behave (as regards the magnetic properties) like a uniaxial substance. The properties of this uniaxial substance can be interpreted by a particular model, which is described. (tr-auth)

5823 RADIATION DEFECTS IN LITHIUM-DOPED SILICON. I. V. Smirnova, V. A. Chapnin, and V. S. Vavilov (Moscow State Univ.). Fiz. Tverd. Tela, 4: 3373-80 (1962).

The effect of lithium on the formation of stable radiation defects in silicon and on the annealing of these defects was studied by determining the temperature dependence of the carrier concentration from the Hall effect. The lithium was introduced into Si single crystals by diffusion annealing (550 to 650°C) from a tin-lithium alloy. The single crystals had a resistivity of 100 ohm · cm; after doping they had n-type conductivity. The carrier concentration lay between 3×10^{14} and 2×10^{17} cm^{-3}. The specimens were irradiated by 0.9-Mev electrons at room temperature. In n-type silicon with lithium up to concentrations of $(1-2) \times 10^{17}$ cm^{-1}, shallow energy-levels arose in the range from 0.06 to 0.14 ev below the bottom of the conduction band, which were related to primary radiation defects, e.g., to pairs of interstitial atoms and vacancies which were separated by different distances. The lithium in the Si crystal interacted with these defects. Such interaction was similar to the processes that occur during the annealing of genetically unrelated vacancies and interstitial atoms. The trapping radius had the same order as the lattice constant, (r_{min} = 5.4×10^{-8} cm). In crystals that, after part of the lithium was deposited in the defects, were again of p-type conductivity, the levels 0.45, 0.28, and 0.21 ev were observed above the top of the valency band. The centers corresponding to the level E_v + 0.28 ev did not disappear completely even during annealing for several hours at 450°C and above; those corresponding to the level E_v + 0.21 ev disappeared completely during annealing at 450°C. (OTS)

5824 SOME PRELIMINARY RESULTS ON DEFECTS IN IRRADIATED UO_2 SINGLE CRYSTALS AS REVEALED BY TRANSMISSION ELECTRON MICROSCOPY. H. Blank and S. Amelinckx (SCK-CEN, Mol, Belg.). J. Appl. Phys., 34: 2200-9(Aug. 1963). (EUR 452.e)

Vapor-grown single crystals of nearly stoichiometric UO_2 have been thinned for transmission electron microscopy. The as-grown crystals show a dense pattern of precipitates and may contain loops due to quenched-in vacancies but contain hardly any dislocations. Two models for the production of loops are proposed. Dislocation networks (small angle boundaries) are produced on annealing the crystals. Irregular patterns of dislocations arise when sufficient thick parts of the crystal foils are treated with heat shocks in the microscope suddenly increasing the beam current. After exposure to 10^{15} nvt the crystal foils show fission tracks, short segments of straight dislocation lines, and black dots, which are partly distributed at random and partly are aligned on fission tracks. Interaction between fission tracks and dislocations has been observed. The conditions for contrast production on fission tracks have been investigated. The experimental findings can be explained by a model of a displacement field around the fission tracks. (auth)

5825 POLARIZATION OF DIELECTRICS BY NUCLEAR RADIATION. II. GAMMA-RAY-INDUCED POLARIZATION. Preston V. Murphy (Laboratorio de Dosimetria, Rio de Janeiro) and Bernhard Gross. J. Appl. Phys., 35: 171-4(Jan. 1964).

The electrical polarization produced in solid dielectrics by gamma ray bombardment is treated as a space charge resulting from the production and absorption of Compton electrons. For a gamma-ray beam in equilibrium with secondary electrons, the calculated net space charge is negative in sign and decreases with distance in proportion to gamma ray attenuation. The distribution of polarization was studied experimentally by cutting away sections of irradiated carnauba wax and measuring the charge released on heating for each section. The relation of thermally released charge to sample polarization and the effect of a temperature gradient are discussed. (auth)

5826 RESISTIVITY CHANGES IN URANIUM IRRADIATED AT LOW TEMPERATURES. Y. Quéré (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater., 9: 290-308(Aug. 1963). (In French)

Resistivity changes induced by neutron irradiation of different grades of uranium at 77 and 20°K were studied. After allowance for growth, which is considerable at these temperatures, there are residual changes in re-

sistivity that reach saturation for deformed uranium irradiated at 77°K and that approach saturation in the other instances. It is impossible to interpret the results in terms of a single fission spike: it is necessary to postulate two distinct volumes, a small one (0.9×10^{-16} cm^3) corresponding, no doubt, to the annihilation of defect clusters in displacement spikes, the other larger one ($3-6.5 \times 10^{-16}$ cm^3) corresponding to the recombination of point defects outside displacement spikes. The probable existence of a whole spectrum of volumes for different types of defects is discussed and it is shown that this generalization does not profoundly modify the foregoing conclusions. (auth)

5827 THE EFFECT OF NEUTRON IRRADIATION ON THE THERMAL CONDUCTIVITY OF BERYLLIUM OXIDE. M. K. Cooper, A. R. Palmer, and G. Z. A. Stolarski (Australian Atomic Energy Commission, Lucas Heights, New South Wales). J. Nucl. Mater., 9: 320-6 (Aug. 1963). (AAEC/TM-181)

The thermal conductivity of irradiated hot pressed beryllia was measured over the temperature range 0-85°C. Increasing fission neutron dose decreases the thermal conductivity and reduces its temperature dependence. At sufficiently high doses, the thermal conductivity remains constant over the temperature range studied. The radioinduced change in conductivity anneals out on heating at elevated temperatures; for two hour anneals, recovery starts at 400°C but is not complete until 1400°C is reached. Irradiation at higher temperatures (500-660°C) causes a considerably smaller change in conductivity than for equivalent doses at pile temperatures (75-100°C). (auth)

5828 THE PRODUCTION OF INTERSTITIAL POINT DEFECTS BY LOW ENERGY ION BOMBARDMENT. P. Bowden and D. G. Brandon (Cambridge Univ., Eng.). J. Nucl. Mater., 9: 348-54(Aug. 1963).

Thin foils of gold, copper, and nickel, prepared for examination in the electron microscope, were bombarded on one surface with a beam of 100 ev singly charged argon ions at normal incidence and were then examined. Dislocation loops were produced near the bombarded surface and it is demonstrated that they are formed by the agglomeration of interstitial point defects. It is suggested that the point defects are injected to a depth in the foil by replacement collision sequences initiated at the surface, and that they subsequently cluster to form dislocation loops. The effect of the temperature of the specimen during bombardment on the damage observed in copper and gold suggests that the point defects that form the damage migrate in the temperature range around 0°C, the range normally associated with stage III resistivity annealing in these metals. (auth)

5829 THE RELATIONSHIP BETWEEN BURN-UP, TEMPERATURE, AND SWELLING IN ALPHA URANIUM. S. Granata and F. Saraceno (SNAN, Milan). J. Nucl. Mater., 9: 367-8(Aug. 1963).

Isothermal curves of burnup and volume increase for uranium irradiated in the high alpha range were plotted. It was found that the relation between volume increase $\Delta V/V$ and burnup b appears to be neither linear nor of the form $(dV/V) \propto b^{\frac{1}{3}}$. The temperature of irradiation appears to be a fundamental parameter in the study of swelling and there is a temperature in the region of 470°C at which the increase in volume for any particular burnup seems to be a maximum. (P.C.H.)

5830 ELEVATED TEMPERATURE EMBRITTLEMENT INDUCED IN A 20 PER CENT CHROMIUM: 25 PER CENT NICKEL: NIOBIUM STABILIZED AUSTENITIC STEEL BY IRRADIATION WITH THERMAL NEUTRONS. A. C. Roberts and D. R. Harries (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 200: 772 (Nov. 23, 1963).

The mechanism responsible for radioinduced embrittlement in a double-vacuum-melted 20% Cr: 25% Ni: Nb stabilized steel was investigated. After thermal and fission neutron irradiation the specimens were tested at room temperature, 750 or 850°C at a strain rate of 2×10^{-4} sec^{-1} in a hard beam autographically recording dynamometer tensile machine operated remotely within a 4 ft thick concrete cell. With the possible exception of 0.2% proof stresses of the samples tested at 750°C, the stress values were not significantly affected by the irradiation; however, the elongations to fracture were markedly reduced at both test temperatures. The elevated temperature embrittlement is a function of the thermal neutron dose and cannot be correlated with the fission (or fast) neutron dose. This is in contrast to the room temperature point defect hardening and embrittlement that is dependent on the fast neutron dose. (P.C.H.)

5831 X-RAY OBSERVATION OF Al SINGLE CRYSTALS UNDER FAST NEUTRON BOMBARDMENT. Zofia Szmid and Stanislaw Szarras (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 385-90(1963).

The mosaic structure of three samples of Al single crystals was studied before and after fast neutron bombardment. A change in the mosaic structure dependent on the dose of the neutrons was ascertained. Some displacements of the individual mosaic blocks after fast neutron irradiation were observed. (auth)

5832 STAGE I RECOVERY SPECTRUM OF PURE COPPER IRRADIATED WITH ELECTRONS OVER THE RANGE 1.25 TO 3.25 Mev. John A. Tesk, E. C. Jones, Jr., and J. W. Kauffman (Northwestern Univ., Evanston, Ill.). Phys. Rev., 133: A288-93(Jan. 6, 1964).

A 99.999% pure copper specimen was irradiated at 20.4°K with 1.25-, 1.48-, 2.15-, 2.25-, and 3.25-Mev electrons. After irradiation at each energy the specimen was isochronally annealed to 60°K. Electrical resistivity at 20.4°K was the parameter measured. The results show that Stage I recovery is more complex than previously expected. The data show eight definite recovery substages and strongly indicates that possibly nine recovery substages exist in Stage I recovery. All substages were relabeled I_1 through I_9 for convenience. The new substages confirmed were labeled I_2, I_7, and I_9. Substage I_2 occurs at 22-23°K and represents 1.5-2% recovery. Substage I_7 occurs at 45°K, is dose-dependent, and appears more clearly resolved after the higher energy irradiations. This substage, I_7, may correspond to the bump found at about 50°K by Nilan and Granato. I_9 occurs at 53-59°K, represents 1% recovery and appears to be dose-dependent. I_9 occurs near the temperature of the II_a substage reported by Sosin and Neely for doped copper. The shape of the isochronal derivative on the high-temperature side of I_5 indicates that another substage, I_6, may be present. A similarity was noted between the recovery spectrum of gold and the new recovery spectrum of copper. A comparison with the results of others concerning the percent recovery associated with I_B and I_C as a function of bombarding electron energy, supports the conclusion that not much change in population of I_B or I_C occurs beyond E = 1.2 Mev. (auth)

5833 EXPERIMENTS ON STAGE III ANNEALING IN THE NOBLE METALS. F. Dworschak, K. Herschbach, and

J. S. Koehler (Univ. of Illinois, Urbana). Phys. Rev., 133: A293-303(Jan. 6, 1964). (TID-19279)

High purity copper, silver, and gold specimens were irradiated with 10-Mev protons near 80°K. An integrated flux of 1×10^{17} p/cm^2 produced a resistivity increase of 3.3×10^{-9} Ω-cm in copper, 7.4×10^{-9} Ω-cm in silver, and 16.6×10^{-9} Ω-cm in gold. The specimens were isothermally annealed in steps of 20°K for 64 min at each temperature from 143 to 363°K. The recovery in stage III follows second-order kinetics with an activation energy of 0.71 ± 0.04 ev for copper, 0.67 ± 0.003 ev for silver, and 0.80 ± 0.04 ev for gold. Distribution curves of the fractional concentration of defects annealing with a given activation energy were calculated. In the case of copper and silver they show a complex structure followed by a large broad maximum at 0.71 ev for copper and 0.67 ev for silver. In gold there is only one large peak at 0.80 ev. The relation of these results to the various models is discussed. (auth)

5834 IONIZATION EXPANSION OF COMPACTED SILICA AND THE THEORY OF RADIATION-INDUCED DILATATIONS IN VITREOUS SILICA. William Primak (Argonne National Lab., Ill.), Edward Edwards, David Keiffer, and Herman Szymanski. Phys. Rev., 133: A531-5(Jan. 20, 1964).

Vitreous silica compacted by pressure at room temperature expands at a very rapid rate when irradiated with soft x rays or in a reactor, about in the ratio of the ionization doses received. A dose $\sim\frac{1}{2}\ 10^{22}$ ev/cm^3 of absorbed ionization energy caused the release of about $\frac{1}{3}$ of the compaction. It is shown that the effect cannot be explained as a static electrostatic effect or a transient general thermal annealing effect. It must be a rapid transient effect associated with the local distortion or energy deposition of the ionization event. The efficiency of the process indicates that each ionization in moderately pressure-compacted silica must be effective or multiply-effective in releasing compaction. The relation of the compacted states of silica—pressure compacted, radiation compacted, shock wave compacted—is discussed. (auth)

5835 DYNAMICS OF RADIATION DAMAGE IN A BODY-CENTERED CUBIC LATTICE. C. Erginsoy, G. H. Vineyard, and A. Englert (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: A595-606(Jan. 20, 1964). (BNL-7309)

Radiation damage was studied by numerically integrating the equations of motion of a large set of atoms on a high-speed computer. The method is applied to a model of α iron. Low energy events were extensively investigated. The primary knock-on atom is found to initiate an extended sequence of correlated replacements, producing an interstitial at some distance and a vacancy on its original site. The interstitial is found to have a split configuration, as was found earlier in copper, but its axis lies along ⟨110⟩. Collision chains are found to be prominent in ⟨111⟩ and ⟨100⟩, and attenuation rates and focusing parameters for these chains are determined. The threshold energy for displacing an atom is found to be highly dependent on the direction of the knock-on. The lowest threshold is found to be 17 ev, for knock-ons directed near ⟨100⟩, and to be about 34 and 38 ev for those directed near ⟨110⟩ and ⟨111⟩, respectively. The probability of displacement for a randomly directed knock-on of energy E is determined for E between 0 and 60 ev. The results are in approximate agreement with experiments of Lucasson and Walker, although more structure is found in the calculated curve than could be tested by the experiments. Pronounced directional effects in low energy electron bombardments of α iron single crystals are predicted. (auth)

5836 EQUIPMENT AND TECHNIQUES FOR LOW TEMPERATURE ELECTRON IRRADIATIONS. L. F. Lowe, C. Jimenez, and E. A. Burke (Air Force Cambridge Research Labs., Bedford, Mass.). Rev. Sci. Instr., 34: 1348-50(Dec. 1963).

A system is described for making low-temperature electron bombardment studies. A liquid-helium dewar is used in conjunction with a 1.2-Mev electron accelerator. Cooling is by conduction, and annealing is accomplished by balancing the helium flow rate through the cooling coils with a heater located within the cooling head. Details of the sample mount are given along with the beam positioning and monitoring devices. (auth)

5837 RADIATION EFFECTS ON GLASS. P. S. Rudolph (Oak Ridge National Lab., Tenn.). p.114-23 of "Eighth Symposium on the Art of Glassblowing." Wilmington, Del., American Scientific Glassblowers Society, 1963.

A brief survey is presented of radiation effects on glass. After a treatment of the principles and processes involved, radioinduced thermoluminescence and discoloration are discussed. Radiation damage and triboluminescence are considered. The irradiation characteristics of different glasses are described. (D.L.C.)

5838 RADIATION DAMAGE TO RADIO PARTS IN A STRONG FIELD OF GAMMA RADIATION. G. Aripov, E. M. Lobanov, and N. Shadiev. p.68-70 of "Radiatsionnye Effekty v Tverdykh Telakh." Tashkent, Uzbek SSR, Izdatel'stvo Akademii Nauk Uzbekskoi SSR, 1963.

The effect of gamma doses on the electrical and mechanical properties of certain industrial types of capacitor was investigated. Capacitors with mica, oil-impregnated paper, electrolyte, and ceramic dielectrics were studied. Several specimens of each type were tested and the results averaged to eliminate the effect of accidental errors. A cobalt irradiator with dose capacity of 650 rep/sec was used, with integral doses escalated from 100×10^6 to 1100×10^6 rep, in steps of 100×10^6 rep. After each dose the parameters were measured and compared with their original values. Certain specimens were irradiated continuously up to 1100×10^6 rep. In the case of a capacitor of 12.56 pf initial capacitance, the measurements revealed no change after 100×10^6 rep, a reduction to 12.44 pf after 200×10^6 rep, and a further reduction to 12.23 pf after 800×10^6 rep. The capacitance of a second specimen of the same type dropped from an initial 12.80 pf to 12.50, 12.55, and 12.78 pf, respectively, after the same doses. A third specimen of the same type behaved similarly to the first. Capacitors of other types, having initial capacitances of 0.0121 μf and 0.0247 μf, changed their capacitances after an integral dose of 1100×10^6 rep to 0.0444 μf and 0.0253 μf, respectively. One capacitor (4635 pf) changed its capacitance under the same conditions to 4622 pf, while another type (1217 pf) remained unchanged. Radiation damage was especially apparent in paper dielectrics, evidently owing to radiolysis of the impregnating oil. Some capacitors showed bulging of the container and seepage of oil and sealing compounds. It was concluded that gamma radiation will shorten the life of capacitors, but that even powerful doses will not lead to immediate failure. (OTS)

5839 APPARATUS FOR IRRADIATING PLASTIC TUBULAR MEMBERS WITH ELECTRONS DEFLECTED BY A

NON-UNIFORM MAGNETIC FIELD. Hugh R. Smith, Jr. (to Temescal Metallurgical Corp.). U. S. Patent 3,104,321. Sept. 17, 1963. Filed June 9, 1960.

The apparatus and method described provide for the uniform irradiation of materials, particularly materials having an elongated configuration such as plastic insulation on an electrical conductor, from a single electron source. A magnetic field is established having a greater strength adjacent to the material to be irradiated than radially outward therefrom. When the electron beam is directed into the magnetic field, the electrons spiral radially inward about the material and the entire exterior surface is irradiated. Continuous processing is achieved by movement of the material through the irradiation zone. (A.G.W.)

METEOROLOGY

5840 UTILIZATION OF AN EXPERIMENTAL MISSILE FOR EVALUATION OF ARTIFICIAL RADIOACTIVE AEROSOL CONCENTRATIONS AT HIGH ALTITUDE.
D. Boclet (CEN, Saclay, France), C. Jehanno, J. Labeyrie, and H. Le Boiteux. p.215-20 of "Space Research." New York, Interscience Publishers, 1960. (In French)

By means of measurements with a Geiger counter at an altitude of approximately 65 km, and following comparison with similar measurements made by Gangnes, Jenkins, and Van Allen at the same geomagnetic latitude, it is concluded that radio-active aerosols above the Southern France tropopause had a concentration less than 100×10^{-12} Curie/m^3. The missile used for this purpose and its performance are briefly described. (auth)

PHYSICS

General

5841 (AROD-2800.12) FUNDAMENTAL PARTICLE PHYSICS. Final Report, September 1, 1962 to August 31, 1963. Bruno Zumino (New York Univ., New York). Oct. 1963. 13p.

Research progress on superconductivity theory, superconductors in weak magnetic fields, field theory, scattering theory, neutrino properties and electromagnetic interaction, behavior of superdense matter, weak electron-neutrino pair interaction, weak interactions, and generalized statistics is summarized. (D.C.W.)

5842 (ASD-TDR-62-720) APPLICATION OF THE FAST CYCLOTRON WAVE OF A MAGNETICALLY FOCUSED ELECTRON BEAM TO FREQUENCY MULTIPLICATION. Shizuo Mizushina and Dean T. Davis (Ohio State Univ. Research Foundation, Columbus). July 1962. Contract AF33(616)-8391. 114p. (AD-291784)

An electron beam focused by an axial magnetic field and subjected to a transverse high-frequency electric field was used to produce power output at harmonic frequencies of the transverse electric field. The resulting rotating electron beam contains a slow and a fast cyclotron wave, and the fast wave interacts with a harmonic coupler to provide output at a frequency that is a multiple of the input microwave frequency. The resulting frequency multiplier was investigated, and the effects of finite beam diameter and the efficiency of coupling of the electrons to both the input and the output couplers are analyzed. The interaction circuits are studied with attention to limitations on interaction efficiency, including relativistic effects. A practical multiplier design is described, and results of experimental work show that the basic theory is reasonably well confirmed in the conversion from X-band to K-band. (auth)

5843 (IITRI-1184-11) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 11, August 16, 1963–November 15, 1963. J. J. Markham (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Dec. 5, 1963. Contract AT(11-1)-578. 54p.

The complete spin-Hamiltonian is derived for the F-center. The gauge-invariant property is used to simplify considerably the results. A new relaxation mechanism is found involving the anisotropic g-shift. It is shown that spin-orbit coupling cannot be a relaxation mechanism of the isolated F-center in alkali halides. A complete derivation of the Hamiltonian for the magnetic hyperfine interaction is given. The singularities are properly taken into account. The results of various previous treatments are compared. The saturation of a portion of the electron paramagnetic resonance spectrum is reported. The experiment was done at very low powers and two saturated regions appeared. The relationship between the absorption and emission coefficients for a strongly trapped defect interacting with black-body radiation is examined. The effect of including nonradiative transitions in the equation of detailed balance is investigated. (auth)

5844 (LA-2987) HARTREE SCATTERING FACTORS FOR ELEMENTS 2 THROUGH 98 AND FOR SEVERAL IONS. Don T. Cromer, Allen C. Larson, and James T. Waber (Los Alamos Scientific Lab., N. Mex.). Oct. 9, 1963. Contract W-7405-eng-36. 95p.

Scattering factors were computed from Hartree self-consistent-field wave functions for the elements of atomic number 2 through 98 and for several of their ions. The values are tabulated as a function of $s = \sin\theta/\lambda$ from $s = 0$ to $s = 1.99$ Å^{-1} at intervals of 0.01 Å^{-1} and are also given as analytic functions. (auth)

5845 (LADC-5876) THE CROSSCORRELATION METHOD OF MEASURING SYSTEM DYNAMIC RESPONSE. J. Douglas Balcomb (Los Alamos Scientific Lab., N. Mex.). Nov. 4, 1963. Contract [W-7405-eng-36]. 16p. (CONF-332-1)

From Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963.

The basic relations of the crosscorrelation method are presented; and variations of the method for dealing with practical cases for which the idealized relations are inaccurate due to finite experiment length, finite bandwidth of the input signal, and uncorrelated noise in the system response signal are discussed and demonstrated. (D.C.W.)

5846 (LADC-5915) AN EXPLOSIVE-DRIVEN HIGH FIELD SYSTEM FOR PHYSICS APPLICATIONS. R. S. Caird, W. B. Garn, D. B. Thomson, and C. M. Fowler (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 9p. (CONF-342-1)

From Conference on Magnetism and Materials, Atlantic City, Nov. 1963.

A simple explosive-driven flux compression system is described for producing magnetic fields in the megagauss range. The flux-trapping device is a seamless hollow stainless steel cylinder driven by a ring of explosive. The initial field is introduced by a coil pair supplied by a 90-kj capacitor bank. The assembly is readily evacuated. During implosion, the experimental volume is free of objectionable debris and asymmetries. Peak fields of 1.2 and 4 Mg are achieved in working diameters of 8.9 and 3.2 mm, respectively. The usable length is about 15 mm at these fields. Several possible applications are mentioned. (auth)

5847 (NP-13401) RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Third Quarterly Progress Report, June 16,–September 15, 1963. R. Novick (Columbia Univ., New York. Columbia Radiation Lab.). 50p.

Precise measurements were made of the zero-field hyperfine intervals in 14y Cd^{113m}. This nucleus is of interest because the last odd neutron is in an $h_{11/2}$ state. On the single-particle model the nuclear moments should be entirely attributable to this nucleon. Cd^{113m} is the lightest nucleus with an $h_{11/2}$ assignment. A precise redetermination was made of the lifetime of the $^3P_1$ state of Zn. This quantity is required for the full interpretation of the Zn^{65} nuclear moments. Apparatus is being constructed for the direct observation of the two-photon decay of the metastable ($2\ ^2S_{1/2}$ state) of the helium ion. A double-resonance study of the hfs of two excited states of the chromium atom is in progress, which should help in the interpretation and understanding of the hyperfine interactions of the transition elements. Theoretical values were obtained for the cross sections for laser quenching of metastable hydrogenic atoms. The ENDOR spectrum of the V_K color center in LiF was observed. The hfs interactions from the first and second lithium nearest neighbors and the first fluorine neighbors were fully resolved. These observations are useful for the elucidation of the structure of the center. Doppler broadening of the Rayleigh scattered light from

small plastic spheres was observed with a laser homodyne spectrometer. The theory of photon echoes is further developed, and it is shown that the radiation damping of the induced electric dipole moment is small enough to permit the observation of echoes. Microwave studies of the superconducting energy gap in zinc are continuing. High-pressure microwave absorption measurements were made on mixtures of CO_2 and N_2. These results are proving useful in the study of models of the atmosphere of Venus. Estimates were made of the feasibility of detecting microwave ozone lines in the upper atmosphere. (auth)

5848 (SC-TM-40-59(51)) PRELIMINARY EXPERIMENTS IN THE RESPONSE OF PARTICLES TO MAGNETIC AND ELECTRIC FIELDS. J. M. Lohse (Sandia Corp., Albuquerque, N. Mex.). June 11, 1959. Contract [AT(29-1)-789]. 22p.

In the presence of a magnetic field, iron particles that are suspended in a viscous fluid will respond by arranging themselves in a lines-of-force pattern. With weak uniform fields of a few gauss and with fine iron powder of a few microns, the pattern becomes one of many parallel micron-size electrical conductors. In the presence of an electric field, metal particles which are suspended in a polar fluid will respond by forming a conducting fiber across the electrode gap. Using micron-size powder particles, the diameter of the conducting fiber is micron size. If the gap is about 0.025 inch, the fiber may be erected with a voltage from 100 to 1500 volts d-c. Fibers were formed with powders of aluminum, nickel, cobalt, molybdenum, iron, tungsten, copper, and gold. The metals whose powders were most responsive to fibration are nickel, cobalt, molybdenum, copper, and iron. Powders of several semiconductors also proved responsive. Powders of the metallic oxides were quite unresponsive. These effects may prove applicable to memory storage systems because they suggest the possibility of erecting parallel conductors of high space density and of making contacts remotely between chosen conductors. (auth)

5849 (SSD-TDR-63-270) ANALYTICAL SOLUTION FOR CONSTANT-ENTHALPY MHD ACCELERATOR. Harold Mirels (Aerospace Corp., El Segundo, Calif.). Nov. 4, 1963. Contract AF04(695)-269. 17p.

A closed form solution is obtained for a constant enthalpy, crossed field accelerator. The one-dimensional inviscid equations of motion are integrated, assuming that the axial variation of electrical energy addition and the area variation are specified. The accelerator is assumed to be segmented, and ion slip effects are ignored. (auth)

5850 (TID-19816) THERMAL PROPERTIES OF SEPARATED METALLIC ISOTOPES. Final Scientific Report, May 1, 1956–October 31, 1963. D. J. Montgomery (Michigan State Univ., East Lansing). Nov. 15, 1963. Contract AT(11-1)-400. 10p.

A research program was conducted to study the use of isotopic mass as a probe for investigation of matter in the aggregate. The studies were concentrated on the properties of Li^6 and Li^7 (lattice constant, bulk density, elastic modulus, electric resistance, melting point, and viscosity) and on lattice vibrations in isotopically pure and mixed Li hydrides and fluorides. The results are described briefly. (D.L.C.)

5851 (UCRL-Trans-960(L)) NUMERICAL ANALYSIS OF THE PROBLEM OF N BODIES (thesis). Jose Renato Iturriaga de la Fuente (Mexico. Universidad Nacional Autonoma, Villa Obregon). Translated for Univ. of California Lawrence Radiation Lab. 1963. 115p.

Some aspects of the N-body problem and the concept of relaxation time are presented, and the equations of motion of systems of 20 to 100 particles are numerically integrated, following Von Hoerner's method. The time of relaxation and the behavior of the energy, radial and transverse speeds, density, angular motion, force field, and some orbits are examined. Effects of changes in initial conditions, particle numbers, and position and time passage on these properties are considered. (D.C.W.)

5852 ON ALTERNATIVE APPROACHES TO GRAVITATION. Leopold Halpern (Copenhagen Univ.). Ann. Phys. (N. Y.), 25: 387-99(Dec. 1963).

Contributions are made to the discussion about the fundamentals of different approaches to gravitation and their advantages. 31 references are given. (auth)

5853 ENERGY BALANCE OF UNIFORMLY ACCELERATED CHARGE. Clement Leibovitz and Asher Peres (Israel Inst. of Tech., Haifa). Ann. Phys. (N. Y.), 25: 400-4(Dec. 1963).

If the electromagnetic field of a uniformly accelerated charge is computed by means of Liénard-Wiechert potentials, it is found that the result does not correspond to a single source. Besides the original uniformly accelerated charge there is also a second charge, which is spread on a plane recessing in the opposite direction with the velocity of light. The work performed by this second charge against the electromagnetic field is equal to the constant rate of radiation of the physical system. This resolves the old paradox of the energy balance of a uniformly accelerated charge, which radiates at a constant rate, although it undergoes no radiation reaction. (auth)

5854 STIMULATED EMISSION FROM $Y_2O_3:Nd^{3+}$. R. H. Hoskins and B. H. Soffer (Korad Corp., Santa Monica, Calif.). Appl. Phys. Letters, 4: 22-3(Jan. 1, 1964).

The single crystal of Y_2O_3 was grown by flame fusion and Nd^{3+} was included as the active ion. Stimulated emission was observed at 1.073 and 1.078 μ at 77°K. The fluorescence spectra are shown for 77 and 300°K. (R.E.U.)

5855 EXPERIMENTS ON EARTH WITH WEIGHTLESS LIQUIDS. V. V. Shuleikin. Dokl. Akad. Nauk SSSR, 152: 1082-5(Oct. 11, 1963). (In Russian)

A stream-lined missile 1200 mm long and 400 mm in diameter at its widest cross-section was designed to study the dynamic behavior of the surface of a liquid under conditions of weightlessness, which occurs momentarily when the missile starts to fall freely. The inside of the missile was equipped with a stand to hold the liquid, a mirror, and a camera that can take 64 frames per second. The time was recorded in hundredths of a second on each frame by photographing the dial of a chronometer. Linear dimensions could be determined from the face of the dial, whose diameter was 30 mm. A light was provided to illuminate the liquid. The missile was ejected by a catapult mechanism used with gliders. After attaining a definite height, the missile strikes a rubber cushion, and begins a free fall of about 4 m (about 0.9 seconds). It is estimated that one complete cycle of oscillations can be observed in 20 g of water or 130 g of mercury within 0.9 seconds. The occurrence of weightlessness was determined by making electrical contact with a spring-loaded mass of 300 g. The first frame was taken 0.04 seconds after the occurrence of weightlessness due to the time lag in activating the camera. The first experiments were carried out with a supersaturated solution of nigrosine in distilled water. The pictures show that water does not assume the shape of a sphere, but rather of a mound with sloping sides. Mercury shows an entirely different behavior. Mercury assumes the profile of a plane disk 0.07 sec after the occurrence of weight-

lessness, and deforms into two spherical drops 0.19 sec after the occurrence of weightlessness. Partial oscillations are observed at 0.27 sec, and a truncated sphere 33 mm in diameter is observed at 0.39 seconds. The spherical shape is retained for the remainder of the free fall. (TTT)

5856 LINEWIDTH AND CONDITIONS FOR STEADY OSCILLATION IN SINGLE AND MULTIPLE ELEMENT LASERS. J. A. Fleck, Jr. (Univ. of California, Livermore). J. Appl. Phys., 34: 2997-3003(Oct. 1963). (UCRL-7274-T)

A derivation is given for the linewidth of an optical maser at steady power, taking into account its peculiar physical configuration and mode structure. Two limiting cases are considered: one in which the number of back and forth reflections between the end plates is not sufficient to establish a mode in the sense of Fox and Li, the other in which such a mode is established. The linewidth for the latter case may be interpreted as the theoretical lower limit. It is pointed out, however, that this limit could not be attained even if all other sources of noise in the maser system could be eliminated. General conditions are also developed for the oscillation of a system consisting of any combination of laser and mirror elements. (auth)

5857 ELECTRON SPIN RESONANCE OF Nd^{3+} IN CADMIUM SULFIDE SINGLE CRYSTALS. Kazuo Morigaki (Sony Corp., Yokohama, Japan). J. Phys. Soc. Japan, 18: 1636-40(Nov. 1963).

The electron spin resonance study of Nd^{3+} in cadmium sulfide single crystal has been done at 1.4°K and X-band. The observed spectra consist of a strong line due to even isotopes and satellite lines coming from the hyperfine interaction with nuclei of odd isotopes. They can be explained by using the spin Hamiltonian, $\mathcal{H} = g_{||}\beta H_z S_z + g_{\perp}\beta(H_x S_x + H_y S_y) + A I_z S_z + B(I_x S_x + I_y S_y)$, where the c-axis of the crystal is chosen as the z-axis. The parameters are $g_{||} = 0.43 \pm 0.05$, $g_{\perp} = 3.409 \pm 0.005$, $|B| = (342 \pm 5) \times 10^{-4}$ cm^{-1} for Nd^{143}, and $|B| = (213 \pm 3) \times 10^{-4}$ cm^{-1} for Nd^{145}. The crystal field around Nd^{3+} in cadmium sulfide has the symmetry of C_{3v}. The ground state ($^4I_{9/2}$) splits into five doublets by this crystal field. Judd's theory of Nd^{3+} in double nitrate is applied to this case to discuss the ground state of Nd^{3+} in cadmium sulfide. The ground state wave function is constructed as a linear combination, $0.2490|9/2, \mp 5/2\rangle \pm 0.9685|9/2, \pm 1/2\rangle$. Besides Nd^{3+} resonance lines, several lines were observed. Paramagnetic centers that are responsible for these lines are discussed. (auth)

5858 LATTICE EXPANSION IN LiF CRYSTALS BY NEUTRON IRRADIATION. Kazuko Kubo and Haruhiko Motohashi (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 18: 1694(Nov. 1963).

The lattice parameter of LiF is studied as a function of neutron dose by x-ray diffraction. The pre-irradiation nature of the specimen is discussed with its effects on the lattice expansion. (R.E.U.)

5859 COLLOIDAL Li METAL IN NEUTRON-IRRADIATED LiF CRYSTALS. Kazuko Kubo (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 18: 1703 (Nov. 1963).

The appearance of colloidal particles of lithium metal in lithium fluoride single crystals after thermal neutron irradiation and thermal annealing is discussed. The dependence of particle formation on neutron dose, annealing temperature, and irradiation temperature is discussed. (R.E.U.)

5860 CURRENT-VOLTAGE RELATIONS FOR MOBILITY-CONTROLLED SHEATHS; A SIMPLE METHOD FOR DETERMINING ION MOBILITY. M. A. Weinstein and C. Kenty (General Electric Co., Cleveland). Nature, 200: 873-4(Nov. 30, 1963).

A method is described for determining ion mobility that is based on current-voltage relations for mobility-controlled sheaths. The theory was applied, together with data on a cylindrical Xe discharge, to measure the mobility of Xe ions. (C.H.)

5861 SOME CONCLUSIONS FROM THE NEW DERIVATION OF $E = mc^2$. S. Smith. Nucl. Energy, 376(Dec. 1963).

Some conclusions from a derivation of $E = mc^2$ that repudiates special relativity were: the mass of a photon when bound in the atom is half its apparent mass when it is free; the relation between the apparent mass of a moving object (m′) and its rest mass (m) is $m' = m \cdot \exp[\frac{1}{2}(v^2)/(C^2)]$; the nucleus can contain only like charges and the electron shells can contain only like charges; no neutral object that can be envisaged as a single entity resulting from the mixture of equal numbers of positive with negative particles can be stable; and the rest mass of the photon in the atom, $m_a = m \cdot \frac{1}{2} e^{\frac{1}{2}}$. (M.C.G.)

5862 IMPURITY DISTRIBUTION AND FORMATION OF COLOR CENTERS UNDER THE ACTION OF X RAYS IN NaCl–Mn, NaCl–Cd, AND NaCl–Pb. L. V. Grigoruk and I. Ya. Melik-Gaikazyan. Opt. Spectry. (USSR) (English Transl.), 15: 210-13(Sept. 1963).

The effect of activator concentration and treatment temperature on the density of F centers and "atomary" centers is investigated for the systems NaCl–$MnCl_2$, NaCl–$CdCl_2$, and NaCl–$PbCl_2$. It is shown that the absorption coefficient at the maximum of the F band and the additional activator absorption bands changes with increasing content of the second component according to a curve that has a maximum. Quenching of crystals with small impurity content leads to an increase in the intensity of the F band, and with large impurity content it leads to a decrease. The results are in agreement with the idea of a continuous distribution of activators in the crystal. (auth)

5863 THE IDENTITY OF METHODS FOR THE COMPUTATION OF THE ISOTOPIC SHIFT IN SPECTRAL LINES. F. A. Babushkin. Opt. Spectry. (USSR) (English Transl.), 15: 232-3(Sept. 1963).

Two methods discussed are displacement of the energy level produced by the finite dimensions of the nucleus expressed by a change in the principle quantum number and displacement in terms of the values of the electron wave functions at the boundary of the nucleus. A unique solution is obtained by using the same wave functions in both methods. (R.E.U.)

5864 DEUTERON INTRABOND MOTION AND FERROELECTRICITY IN KD_2PO_4. Henry B. Silsbee (Univ. of Washington, Seattle), Edwin A. Uehling, and V. Hugo Schmidt. Phys. Rev., 133: A165-70(Jan. 6, 1964).

The Slater theory of the ferroelectric phase transition in KH_2PO_4 type crystals as modified by Takagi and extended by Senko is examined again in the light of recent measurements of parameters made on KD_2PO_4. Making full use of the measurements, and assigning an appropriate numerical value to one adjustable parameter that is not independently measured, the theory gives a nearly correct description of the shape of the spontaneous polarization curve. Also the value obtained for the Curie constant is probably satisfactory in view of limitations of the model and uncertainty of the high-temperature experimental data. The theory fails, however, in at least one important respect; the transition

entropy is overestimated. This and other discrepancies are discussed briefly. (auth)

5865 MOELLER'S ENERGY MOMENTUM PSEUDOTENSOR AND ITS APPLICATION TO THE BORN-INFELD MODEL OF A CHARGED PARTICLE. F. H. J. Cornish (Univ. of Leeds, Eng.). Proc. Phys. Soc. (London), 82: 807-15(Dec. 1, 1963).

A derivation is given of both the Einstein and Møller total energy-momentum conservation laws in general relativity from Komar's covariant identity. The Einstein and Møller theories are briefly compared. The main purpose is to use the Møller theory to obtain the energy distribution in the field associated with the Born-Infeld model of a charged particle incorporated in general relativity. It is shown that the Maxwell-Einstein point charge may be regarded as a limiting case of the Born-Infeld model provided an infinite negative mass of nonelectromagnetic origin is introduced to compensate for the infinite Maxwell self-energy. (auth)

5866 THE THERMODYNAMICS OF SPINS COUPLED TO LATTICES. F. Persico and K. W. H. Stevens (Univ. of Nottingham, Eng.). Proc. Phys. Soc. (London), 82: 855-64 (Dec. 1, 1963).

The usual assumption that the specific heat of a paramagnetic crystal can be written as the sum of a lattice specific heat and a spin specific heat needs modification when there is strong spin-lattice coupling. The necessary theory is developed for two simple examples, and it is shown to lead to an increase in the maximum of the Schottky specific heat. It is suggested that the previously unexplained magnitudes of the specific heat maxima in cerium and praseodymium ethyl sulfates arise from strong spin-lattice couplings. (auth)

5867 CONFIGURATION INTERACTION IN RARE EARTH IONS. B. R. Judd (Centre National de la Recherche Scientifique, Bellevue, France). Proc. Phys. Soc. (London), 82: 874-81(Dec. 1, 1963).

An analysis is given of the interaction between the electronic configurations $(nl)^N(n'l')^{4l'+2}$ and $(nl)^N(n'l')^{4l'+1}(n''l'')$, and of the way it affects the matrix elements of a single-particle double-tensor operator $T^{(kk)}$. The theory is applied to rare earth ions, for which nl ≡ 4f. It is shown that the infinite sums that occur in the calculation of the corrections to the spin-orbit coupling due to this kind of configuration interaction can be related to the corresponding sums that occur when the corrections to the orbital part of the magnetic hyperfine interaction are analyzed. Deviations between theoretical and experimental values of the spin-orbit coupling constant for rare earth ions are used to estimate the adjustments that should be made to $(1/r^3)$ when calculating the magnetic hyperfine interaction. The effective values of this quantity thus obtained are found to be in excellent agreement with experiment. Some discussion is given of the calculation of the analogous adjustments to $(1/r^3)$ for the quadrupole interaction. (auth)

5868 STABILITY OF THE NUCLEAR FERROMAGNETIC STATE. P. Lal (The University, Liverpool). Proc. Phys. Soc. (London), 82: 882-99(Dec. 1, 1963).

The possible establishment of a nuclear ferromagnetic state of a metal depends on the hyperfine interactions between the electron and the nuclear spins. Since this interaction is of very short range (δ-like), methods were developed that, in contrast to previous treatments, avoid the use of perturbation theory. An explicit condition was established that shows whether or not a metal should exhibit nuclear ferromagnetism at very low temperatures. This condition depends on details of the electronic wave functions. It is satisfied in the case of sodium but not satisfied for metallic hydrogen. (auth)

5869 MOMENTUM DISTRIBUTION OF ELECTRONS IN METALLIC LITHIUM. G. E. Kilby (The University, Sheffield, Eng.). Proc. Phys. Soc. (London), 82: 900-2 (Dec. 1, 1963).

Discrepancies between experimental and theoretical results for the shape of the Compton line in x-ray scattering from metallic lithium are examined. The effect of electron correlations on the Compton profile is first examined using the high density momentum distribution of an electron gas as given by Daniel and Vosko. The smallness of the effect leads to an examination of earlier work based on approximate Bloch wave functions. By using experimental binding energies in conjunction with the virial theorem it is shown that the mean kinetic energy of the conduction electrons in lithium is almost certainly overestimated by earlier work and is about 7 ev. Such a figure indicates an even greater discrepancy between theory and experiment. (auth)

5870 APPLICATION OF SPIN WAVE THEORY TO THREE MAGNETIC SALTS. G. G. Low (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 82: 992-1001(Dec. 1, 1963).

Numerical calculations, based on spin wave theory, were carried out in connection with the magnetic properties of two simple ferromagnetic salts, EuO and EuS, and the antiferromagnetic compound MnF_2. The resulting predictions regarding magnetization and specific heat were compared with experiment over a wide temperature range. The calculations envisage the possibility that more than one set of exchange interactions may be involved and in the case of MnF_2 allowance is made for a temperature dependent anisotropy field. Account is taken of two-magnon dynamical interactions and renormalized spin wave energies are used in evaluating the magnon populations. The effects of kinematical interactions between spin waves are, however, ignored. It is found that the theoretical estimates of magnetization appear to fit experiment over a temperature range extending to about three-quarters of the Curie or Néel temperature of the system concerned. Specific heat calculations, on the other hand, seem to depart from the experimentally observed values at a much lower temperature, of the order of one-third the critical temperature. The calculations on EuO and EuS confirm the general model for the exchange constants of these salts proposed by McGuire, Argyle, Shafer, and Smart and by Gorter and his co-workers. (auth)

5871 DIFFUSION ON NON-INTERACTING PARTICLES IN CYLINDRICAL GEOMETRY. R. J. Fleming (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 82: 1006-9(Dec. 1, 1963).

The mean number of collisions surrered by electrons in diffusing from the inner to the outer radius of a hollow infinite cylinder is calculated using a development of a method previously outlined by McClure for spherically symmetrical problems. His approach appears to be superior to the standard Harries-Hertz treatment in that it takes variation of total diffusion time into account at an early stage; it also appears to be applicable at lower gas pressures. It is shown that utilization of the Harries-Hertz formula in the classical Maier-Leibnitz experiment leads to a 5% overestimate of the inelastic electron collision cross sections of the helium atom for electron energies near the metastable threshold, in so far as the

present calculation and that of Harries and Hertz are applicable to Maier-Leibnitz's apparatus. The total error in his cross section values is probably not less than 30%. (auth)

5872 ROTATIONAL ANALYSIS OF A SYSTEM B $^1\Sigma^+ \leftarrow$ X $^1\Sigma^+$ OF BeS. W. J. M. Gissane and R. F. Barrow (Oxford Univ.). Proc. Phys. Soc. (London), 82: 1065-6(Dec. 1, 1963).

A singlet system B $^1\Sigma^+$–X $^1\Sigma^+$ ascribed to BeS was observed in absorption at 1900°C. Values of the constants are

	T_{00}	ω_e	r_0(Å)
B $^1\Sigma^+$	25868	850.4	1.818
X $^1\Sigma^+$	0	997.4	1.745

The lower state X $^1\Sigma^+$ appears to be the ground state of BeS. (auth)

5873 ROTATING COORDINATES IN SCATTERING THEORY. A. M. Arthurs (Univ. of York, Eng.) and A. R. Holt. Proc. Phys. Soc. (London), 82: 1073-4(Dec. 1, 1963).

The procedure of using rotating coordinates in scattering problems, which can be justified for exact calculations, breaks down in calculations based on Born approximation. (auth)

5874 EXACT METHOD FOR THE CALCULATION OF X-RAY TRANSMISSION FACTORS IN CRYSTALS OF RECTANGULAR CROSS SECTION. L. Muldawer (Temple Univ., Philadelphia). Rev. Sci. Instr., 34: 1453-4(Dec. 1963).

An exact integration is carried out to determine x-ray transmission factors for rectangular shapes. (R.E.U.)

5875 EFFECTIVE DEPTH OF THE PHOTOEFFECT EXCITED BY SOFT X RAYS. N. G. Nakhodkin and P. V. Mel'nik (Kiev State Univ.). Soviet Phys.-Solid State (English Transl.), 5: 1259-61(Dec. 1963).

The photoelectron emission from KCl layers excited by soft x rays is investigated. It is shown that slow electrons predominate in the photoelectrons emitted into a vacuum, and that the higher photoemission of KCl layers compared with metals is due, as is secondary emission, to the large number of slow electrons. The effective photoemission depth excited by quanta of 1 kev was found to be the same order of magnitude as that for secondary emission. Thickness dependences of the photoeffect were investigated for various substances at energies of 0.28 to 9 kev. (R.E.U.)

5876 INVESTIGATION OF THE COSMIC SPACE AND OF THE UPPER LAYERS OF THE ATMOSPHERE. A. A. Blagonravov. Vestn. Akad. Nauk SSSR, 33: No. 9, 9-16 (Sept. 1963). (In Russian)

The main achievements of the Soviet space research consists in the successful flights of the spaceships Vostok-1 to Vostok-6; in addition, the interplanetary experimental stations Mars-1 and Luna-4 yielded valuable information on various space problems, while the Kosmos series of satellites were used for studying the ionosphere, corpuscular radiation from the Sun, and for the regular survey of the upper layers of the atmosphere. The studies carried out by means of Mars-1 launched from a satellite confirmed the useability and reliability of the modulated communication system operating at distances up to 106 million km. It was found that the cosmic radiation beyond the boundaries of the Earth's magnetic field increased by a factor of nearly 2; this is probably due to changes in the solar activity cycle. The electron flux in the center of the upper belt of charged particles was found to be (2 to 4) $\times 10^8$ $cm^{-2}sec^{-1}$. Tests with the Kosmos satellites showed marked differences in the charged particles during the years 1958 and 1962: the decrease of the concentration with height directly above the main ionization maximum became more accelerated and at a height of 600 km, instead of the previously predominant atomic ions, He ions were observed. During 1962, 72 research rockets were launched for studying the temperature, density, and the wind distribution in the upper atmosphere. The reflection of radio waves from Mars, Venus, and Mercury were investigated at a frequency of about 700 megahertz. (TTT)

5877 MOVEMENT OF CHARGED PARTICLES IN A SPIRAL CUBIC STRAIGHT FIELD. Yu. F. Orlov. Zh. Eksperim. i Teor. Fiz., 45: 932-5(Oct. 1963). (In Russian)

A solution is obtained for the equations of motion of a particle in a spiral cubic straight magnetic field. The method for solving the equations may be employed for investigating an arbitrary spiral nonlinear field. (auth)

5878 TYPICAL STRUCTURE OF A TOROIDAL MAGNETIC FIELD. A. I. Morozov and L. S. Solov'ev. Zh. Eksperim. i Teor. Fiz., 45: 955-9(Oct. 1963). (In Russian)

The forms of the elementary structures of a toroidal magnetic field are found, and the problem of the structure of the field as a whole is discussed. (auth)

5879 QUASICLASSICAL SCATTERING IN A CENTRALLY SYMMETRIC FIELD. A. Z. Patashinskii, V. L. Pokrovskii, and I. M. Khalatnikov (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 989-1002(Oct. 1963). (In Russian)

The amplitude is found for quasiclassical scattering in a central-symmetric field into angles that classically are unattainable. The position of Regge poles and of the asymptotic values of the scattering matrix in the complex momentum plane are investigated for a certain class of potentials U(r) at energies E satisfying the conditions $E \gg |U(r)|$ on the real axis r and $\lambda \ll a$ (λ is the wave length of the impinging particle). (auth)

5880 REGGE TRAJECTORY FOR POSITRONIUM ATOM. Yu. M. Malyuta (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 1167-8(Oct. 1963). (In Russian)

A previously proposed approximation method is used for determining the positronium energy spectrum. (auth)

5881 MÖSSBAUER EFFECT OF Sn^{119} NUCLEI IN A VANADIUM MATRIX. V. A. Bryukhanov, N. N. Delyagin, and Yu. Kagan (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1372-7(Nov. 1963). (In Russian)

The probability for resonance recoilless absorption of 23.8-kev γ quanta by Sn^{119} nuclei in a vanadium matrix is measured at temperatures from 77 to 660°K. The measurements are performed for rigid solutions with tin concentrations of 1.6, 3.45, and 7.22 atomic percent. The experimental data are directly compared with theory. The density function of the phonon frequency spectrum of vanadium experimentally determined was employed. Satisfactory agreement between theory and experiment is observed throughout the whole temperature range. Within the experimental errors no difference in the effect was observed for samples with any of the three concentrations. (auth)

5882 RELAXATION PROCESSES IN PARAMAGNETIC RESONANCE OF Gd^{3+} IONS IN CaF_2 CRYSTALS. A. A. Manenkov and Yu. E. Polskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1425-9(Nov. 1963). (In Russian)

Relaxation processes of Gd^{3+} ions in the fluorite lattice are studied at a frequency of 9370 M by the pulse saturation method at liquid helium temperature. The relaxation times for Gd^{3+} ions in crystal fields of various symmetry are determined. The relaxation times for ions in a tetrag-

onal or trigonal field weakly depend on the temperature. The absence of a concentration dependence of the spin-lattice relaxation time is discussed. Spin-spin cross relaxation times are measured at concentrations of 3×10^{-4} and 5×10^{-4}. Cross relaxation effects are discussed. (auth)

5883 INTERACTIONS OF SHOCK WAVES IN MAGNETOHYDRODYNAMICS. N. L. Tsintsadze and Ts. D. Loladze. Zh. Tekhn. Fiz., 33: 1206-9(Oct. 1963). (In Russian)

Interactions of symmetric magnetohydrodynamic shock waves were investigated, and cumulative convergence angles were determined. It is shown that with strong shock waves the increase of pressure in the presence of a magnetic field is much less than in ordinary hydrodynamics. Magnetohydrodynamic shock reflection from an ideally conducting wall was also studied. (R.V.J.)

5884 BULK PROPERTIES OF STABLE ISOTOPES AS A PROBE FOR LIQUID-STATE AND SOLID-STATE INVESTIGATIONS. D. J. Montgomery (Michigan State Univ., East Lansing). p.468-76 of "Metallurgy and Fuels." New York, Pergamon Press, 1961.

For isotopes of the same element, the atomic mass can be changed while the atomic force field remains constant. The physical properties of lithium are investigated using this principle. The lattice constant, bulk density, electric resistivity, thermoelectric force between Li^6 and Li^7, melting point, and liquid-state investigations are discussed. (R.E.U.)

5885 PROCEEDINGS OF NUCLEAR ENERGY CONFERENCE, FEBRUARY 11-13, 1963, ARKANSAS POLYTECHNIC COLLEGE, RUSSELLVILLE, ARKANSAS. Eugene Sharp, ed. [Russellville, Arkansas, Arkansas Polytechnic College, 1963]. 169p.

Eight articles are included; separate abstracts were prepared for 6. The articles not included in NSA contain information on the Manned Spacecraft Center and the unseen world. (P.C.H.)

For abstracts of individual papers see: 5123, 5491, 5566, 5567, 5568, and 6056.

Accelerators

5886 (CERN-63-33) DISC-LOADED DEFLECTING WAVEGUIDE. H. G. Hereward and M. Bell (European Organization for Nuclear Research, Geneva). Oct. 15, 1963. 67p.

The theoretical basis of a computer program for calculating the properties of the disc-loaded circular waveguide that will carry the deflecting r-f field in the CERN r-f particle separator is presented. (D.C.W.)

5887 (NP-13331) VYVOD CHASTITS IZ PROTONNOGO SYNKHROTRONA ITEF I OBZOR OSNOVNYKH PUCHKOV. (Particle Extraction from ITEF Synchrotron and a Review of Main Beams). L. L. Gol'din, L. I. Sokolov, V. S. Kuryshev, and Yu. M. Gor'yachev (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol' zovaniyu Atomnoi Energii). 1963. 25p.

Extraction of beams from the ITEF proton synchrotron was studied, and descriptions are given of targets for fast and extended secondary beam extraction. Descriptions are also given of the experimental rooms. Brief descriptions of extracted beams are included. (R.V.J.)

5888 (TG-230-T390) COHERENT RADIATION OF ELECTRONS IN A SYMCHROTRON IN THE CENTIMETER WAVE REGION. A. M. Prokhorov. Translated by B. W. Kuvshinoff (Johns Hopkins Univ., Silver Spring, Md.), from Radiotekhn. i Elektron., No. 1, 71-8(1956). 12p.

The coherent radiation of electrons in a 5-Mev synchrotron of 8-cm radius was experimentally studied. An electrical field having twice the rotational frequency of the electrons was used for acceleration. The 16th and 24th harmonics were studied (λ = 3 and 2 cm, respectively). The radiation measured at these harmonics was about 10^{-6} watt, which agrees sufficiently well with calculations. The initial and final dimensions of the bunch in the synchrotron were determined from the dependence of the coherent radiation on the strength of the magnetic field. This yielded 135 and 97°, respectively, which also agreed with calculations. (auth)

5889 HELICITY AND TRANSVERSE MOMENTUM OF AN EXTREMELY RELATIVISTIC FERMION IN A CIRCULAR ACCELERATOR; EFFECT OF THE RADIAL LIMITATION OF THE BEAM. Olivier Costa de Beauregard (Institut Henri Poincaré, Paris). Compt. Rend., 257: 3327-30(Nov. 25, 1963). (In French)

Solutions for the motion of an extremely relativistic spin-½ particle in a cylindrically symmetric geometry are obtained for the region $0 < a \leq r \leq b < \infty$. In $a \leq r \leq b$, the solutions and their derivatives have zeros. The presence of a time-independent magnetic potential that is purely tangential is assumed. (T.F.H.)

5890 ATOM SMASHER BEAMS 10^{13} PROTONS. Argonne Accelerator Will Double World's Particle Research Capabilities. Cletus Wiley. Electronics, 37: No. 1, 81-2(Jan. 3, 1964).

Some features of the Argonne National Laboratory's Zero Gradient Synchrotron (ZGS) are discussed. Proton generation is followed from the hydrogen source, through acceleration to 12.5 Bev, and then drawing off for experimental use. (R.E.U.)

5891 OPERATION OF A LARGE PARTICLE ACCELERATOR. Pierre Germain (CERN, Geneva). Ind. At., 7: Nos. 9-10, 61-73(1963). (In French)

Some technical and human aspects of the operation of a large particle accelerator are given. A description of the accelerator gives an idea of the order of magnitude of the problems and a classification of the operation activities defines their nature. The quality and the quantity of the physics studies made with the accelerator are at the base of the majority of the technical problems to be resolved. Some of these are described. The human factor in the operation is then examined, and the experience acquired during the first three years of operation of the CERN proton synchrotron is reviewed. (tr-auth)

5892 PRODUCTION OF MULTI-CHARGED NEON IONS IN PULSED SOURCE FOR CYCLOTRONS. A. S. Pacyuk, I. A. Shelaev, Chi-chien Kuo, and Yu. P. Tretyakov (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 5, 23-5(Sept.-Oct. 1963). (In Russian)

The design and performance of a multi-charged ion source are presented. For acceleration in a cyclotron an average current of 100-150 μ amp of tetravalent Ne^{20} ions is produced. (tr-auth)

5893 PRODUCTION OF SHORT PULSES OF RADIATION IN BETATRONS WITH LARGE GAP. V. A. Moskalev and Yu. A. Otrubyannikov (Scientific Research Inst. for Nuclear Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 5, 26-9(Sept.-Oct. 1963). (In Russian)

A system adapted for the production of radiation pulses

of 0.5 μ sec duration in betatrons is presented. The contracted duration of the radiation pulse is accomplished in two stages. The electrons in equilibrium orbits move in a smoothly expanding orbit and then are suddenly ejected toward the target. (tr-auth)

5894 APPLICATION OF PERIODIC AZIMUTHAL MAGNETIC FIELD PERTURBATION FOR PARTICLE BEAM EXTRACTION FROM STRONG-FOCUSING SYNCHROTRONS. I. A. Shukeilo. Zh. Tekhn. Fiz., 33: 1227-31(Oct. 1963). (In Russian)

Azimuthally periodic orbital deformations near betatron and synchrotron oscillations were investigated, considering internal target irradiation and beam extraction from synchrotrons with strong focusing. A quantitative analysis was made of nonstationary processes in orbit excitation. Technical aspects of various conditions are discussed. (tr-auth)

5895 ACCELERATOR PROGRAM (Q-1135) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1061)

This package contains 20 drawings. Equipment components used in the accelerator program for the 3-Mev and 5-Mev Van de Graaff generators are shown. These components include: hyperbolic lens designs, Nos. 2, 3, 4, and 5; beam control apparatus, including beam deflectors and a beam wiggler; a post acceleration pulser; and a beam buncher. (F.S.)

5896 ACCELERATOR TUBE, MARK IV, 600 kv (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1064)

This package contains 1 drawing. The accelerator tube is used in the DCX-2 injection system. This tube uses epoxy skirts that are cast around porcelain insulators. The tube was operated above 600 kv but not reliably above 570 kv. This same type tube also works well on the High Intensity Beam Facility. Beam current may be measured as a function of time with a resolution of the order of 10 μsec. (F.S.)

Astrophysics and Cosmology

5897 (JPL-TR-32-371) PRIMITIVE LEAD FROM IRON METEORITES. Royal R. Marshall and Juerg Feitknecht (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Feb. 4, 1963. Contract NAS 7-100. 18p.

Isotopic analyses show that the Odessa iron meteorite, as well as the Toluca iron meteorite, contains the primeval lead that was first discovered in the troilite obtained from the Canyon Diablo and Henbury iron meteorites. However, significant variations of isotopic ratios occur within all these meteorites. Lead from samples of the Odessa meteorite has unusually large amounts of Pb^{208} that increase with the bismuth content. Nuclear synthesis may account for the differences in isotopic composition found in different samples of this meteorite. There is no suggestion of transitions towards the radiogenic type of lead observed in some iron meteorites (including Toluca). Within the limits of error, the sample of the Piñon nickel-rich ataxite contained no detectable lead. This result corroborates independent measurements that indicate that this type of iron meteorite contains at the most only a few hundredths' ppm of lead. Octahedrites, on the other hand, may contain as much as 0.25 ppm of lead. (auth)

5898 ON THE ACCELERATION OF PARTICLES IN SHOCK FRONTS. E. Schatzman (Carnegie Institution of Washington, D. C.; California Inst. of Tech., Pasadena; and Institut d'Astrophysique, Paris). Ann. Astrophys., 26: 234-49(May-June 1963). (AFOSR-2249)

Charged particles can be accelerated in a perpendicular magnetohydrodynamic shock wave. The scattering of particles by the clumpiness of the magnetic field provides the statistical mechanism that is at the origin of the energy spectrum. The energies that can be obtained are quite high, even for weak shocks. The stronger the shock, the larger is the number of accelerated particles. It is possible to derive the energy spectrum, which obeys a power law, deeply related to the nature of the clumps, which can be those found in collision-free shocks. The conditions for excelleration (injection in the accelerating process) are the same as those for the existence of the clumps in collision-free shocks. These results are applied to surface nuclear reactions and provide a good explanation of He^3 in 3 Cen A and Li in lithium stars. (auth)

5899 CADMIUM ABUNDANCES IN METEORITIC AND TERRESTRIAL MATTER. R. A. Schmitt, R. H. Smith, and D. A. Olehy (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Geochim. Cosmochim. Acta, 27: 1077-88(Nov. 1963).

Abundances of cadmium were determined by neutron activation analysis in 31 meteorites: 0.52–1.16 ppm in five carbonaceous chondrites; 0.015–0.12 ppm in six ordinary bronzitic and hypersthenic chondrites; 0.042–3.3 ppm in three enstatitic chondrites; 0.022 and 0.065 ppm in two eucritic achondrites; 0.18 and 1.79 ppm in two nakhlitic achondrites; ≤0.010 and 0.33 ppm in two calcium-poor achondrites; <0.004 and 0.056 ppm in two mesosiderites; 0.13 and 0.33 ppm in two pallasites; 0.0085 to 0.056 ppm in seven iron meteorites. An atomic abundance of $Cd/10^6$ Si atoms of 1.8 ± 0.6 was calculated for five carbonaceous chondrites, which agrees well with the solar value of 1.5. Cadmium abundances in two terrestrial basalts were 0.33 and 0.5 ppm and 0.026 and 0.24 ppm in two deep-seated eclogites. Abundances of cadmium and other chalcophilic elements are discussed in terms of chondritic parent models. Low fractional abundances in the earth's crust of the chalcophilic elements cadmium (0.00085), zinc (0.0014), bismuth (0.0045), and thallium (0.33), corroborate previous conclusions that either the earth's original composition was not chondritic-like, or that elements like the alkalis (and the chalcophilics) reside below the crust. (auth)

5900 GAMMA-SPECTROMETRIC DETERMINATIONS OF THORIUM, URANIUM AND POTASSIUM IN TEKTITES. R. D. Cherry and John A. S. Adams (Rice Univ., Houston, Tex.). Geochim. Cosmochim. Acta, 27: 1089-96(Nov. 1963).

Thorium, uranium, and potassium were determined in nine tektites and two Peruvian glasses by a non-destructive gamma-spectrometric technique. The nine tektites include three indochinites from Thailand, one indochinite from China, two bediasites, one philippinite, one moldavite, and one australite. The average thorium, uranium, and potassium contents of these samples are 11.9 ppm, 2.0 ppm, and 1.9%, respectively. Attention is drawn to the rather high (average, 6.0) Th/U ratio observed for the tektites. Previous thorium and uranium data on tektites are tabulated and compared with the results. (auth)

5901 ELEMENTAL AND ISOTOPIC ABUNDANCES OF MOLYBDENUM IN SOME METEORITES. V. Rama Murthy (Univ. of California, La Jolla). Geochim. Cosmochim. Acta, 27: 1171-8(Nov. 1963).

The isotopic composition of molybdenum in eight iron meteorites and one stone meteorite, as well as the isotope composition of zirconium in one stone and one iron meteorite, are reported. Molybdenum and zirconium in some meteorites are similar in their isotopic abundances to

terrestrial samples. The anomalies previously reported in the other meteorites are considered doubtful because of some observed mass fractionation during analysis, and because of the fact that the anomalous Mo in Aroos meteorite was not found in another sample of Aroos taken about 6 cm from the first sample. The elemental abundance of molybdenum in seven iron meteorites was determined by isotope dilution method. The concentration of molybdenum was found to range from 6.2 to 7.4 ppm in all types of iron meteorites investigated. (auth)

5902 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder Colo.). J. Geophys. Res., 68: 6537(Dec. 15, 1963).

Data are presented for geomagnetic activity during Aug. 1963. Magnetic character figures, average amplitudes, and 3-hr range indices are given. Provisional sunspot numbers are also given. (C.E.S.)

5903 STUDY OF THE UPPER ATMOSPHERE BY MEANS OF COSMOS 3 AND COSMOS 5 SATELLITES. 4. DENSITY OF THE UPPER ATMOSPHERE AT ALTITUDES OF 200-230km. M. Ya. Marov. Kosmich. Issled., 1: 143-6(1963).

From results of ionospheric investigations made by the Cosmos 3 and Cosmos 5 satellites, some deductions were made on atmospheric density, based on observed decelerations of the satellites as they passed through their perigees. Variations in orbital period and in perigee altitude are presented as a function of several months of orbiting time and are plotted for comparison against satellite latitude and local time. The resulting graph for Cosmos 5 for the period June to November 1962 shows that the perigee fluctuated periodically between extremes of about 190 and 208 km. These periodic fluctuations are ascribed mainly to the nonsphericity of the earth and to the fact that the center of gravitational attraction is not coincident with the earth's center. Also, orbit time was shortest and perigee altitude highest when the perigee occurred at high southern (winter) latitudes and on the earth's night side, i.e., during the coldest ionospheric conditions. Analogous results were found for Cosmos 3 for the April to May interval. Expressions were developed that relate the rate of retardation to atmospheric density in the vicinity of the perigee. From the retardation data of the two satellites it was thus possible to estimate a range of densities in the region of 200 to 230 km; this was done after assuming values of 30 to 60 km for the height of the nominally uniform troposphere. Limits of density so derived were 5.8 to 4.1×10^{-13} g/cm^3 at 200 km and 3.7 to 2.6×10^{-13} g/cm^3 at 230 km. (AID)

5904 ENHANCEMENT OF LIGHT OUTPUT FROM A SUPERNOVA. S. A. Colgate (Univ. of California, Livermore) and A. G. W. Cameron. Nature, 200: 870-2(Nov. 30, 1963). (UCRL-7502)

A possible mechanism to account for the intense light flashes observed in the supernova 3C 273 is presented. The mechanism is based on the theory that collective formation of a cluster of more massive stars with similar evolutionary time-scales may result in numerous Type II supernova explosions in a limited period of time. It is suggested this may account for the large energy radiated by strong radio sources. (C.H.)

5905 ACTIVE DARK FILAMENTS AND TYPE III BURSTS. A. Tlamicha and T. Takakura (Tokyo Astronomical Observatory). Nature, 200: 999(Dec. 7, 1963).

Simultaneous observations of a spectrohelioscope and radiometers at 231 and 260 Mcs were made, showing a clear time coincidence between a type of group of bursts, even when the duration is short, and active dark filaments without flare in more than 15 cases during 1960-62. The bursts seemed to be type III. (M.C.G.)

5906 MODIFICATION OF THE LUNAR SURFACE BY THE SOLAR-WIND BOMBARDMENT. G. K. Wehner, C. E. Kenknight, and D. Rosenberg (General Mills, Inc., Minneapolis). Planetary Space Sci., 11: 1257-61(Nov. 1963).

Long-duration, solar-wind sputtering conditions were simulated at a much accelerated scale with mass-separated hydrogen ion beams or in low-pressure, noble gas or hydrogen plasmas. Experiments with metal targets and metal-, oxide-, and rock-powder samples demonstrate the leveling and smoothing of macroscopic surface features, and cementing together of loose particles into a porous, brittle, fibrous crust. Certain oxide surfaces become enriched with metal atoms under the bombardment and sputtering action. It is concluded that many of the unusual properties of the lunar surface can be explained by the action of solar-wind bombardment. (auth)

5907 SPACE RESEARCH. Proceedings of the First International Space Science Symposium, Nice, January 11-16, 1960. Hilde Kallmann Bijl, ed. New York, Interscience Publishers, 1960. 1206p. $24.00.

Topics including the atmosphere, the ionosphere, tracking and telemetering, solar radiation, cosmic radiation, interplanetary dust, the moon, and the planets are discussed. Abstracts are presented for 29 of the 98 papers. (C.E.S.)

For abstracts of individual papers see: 5840, 5908, 5909, 5910, 5951, 5952, 5953, 5954, 5955, 5956, 5957, 5958, 5959, 5960, 5961, 5962, 5963, 5964, 5965, 5966, 6092, 6093, 6094, 6095, 6096, 6097, 6098, 6099, and 6100.

5908 THE X-RAY RADIATION OF THE SUN. C. de Jager (Rijksuniversiteit, Utrecht). p.628-36 of "Space Research." New York, Interscience Publishers, 1960.

The solar hard x rays, with observed energies up to one Mev, originate as bremsstrahlung due to the braking of high velocity electron jets in the flare or photosphere. A sufficient acceleration of these jets can only be obtained in cool and magnetically neutral regions, hence in flares. A flare should not be considered as a solar lightning but originates by a local sudden high compression of the coronal or chromospheric plasma, followed by a cooling of the coronal gas. The average induced electric fields are small but under circumstances, perhaps in shock fronts, the fields may increase to 10^4 and even 10^6 ev. Arguments are given to show that type III moving radiobursts are due to similar electron jets that are not braked. (auth)

5909 PROPERTIES OF CHROMOSPHERIC ERUPTIONS ASSOCIATED WITH COSMIC RAY PRODUCTION BY THE SUN. J. F. Denisse, A. Boischot, and M. Pick-Gutmann (Observatoire de Paris, Meudon, France). p.637-48 of "Space Research." New York, Interscience Publishers, 1960. (In French)

Some chromosphere flares are associated with the production of cosmic rays that are detected near the earth either directly by means of balloons or satellites, or indirectly by occurrence of a polar black-out. With a few exceptions, these flares are of importance 3 and 3^+ and are followed by the most intense type IV radio bursts. The propagation of cosmic rays towards the earth seems easier when the flare is on the west side of the sun. Radio observations indicate the existence of high-energy electrons that are trapped near the sun for a few days after these flares. (auth)

5910 X-RAY EMISSION ACCOMPANYING SOLAR FLARES AND NON-FLARE SUNSPOT MAXIMUM CONDITIONS. T. A. Chubb, H. Friedman, and R. W. Kreplin (Naval Research Lab., Washington, D. C.). p.695-701 of "Space Research." New York, Interscience Publishers, 1960.

Preliminary results on the x-ray emission accompanying a class 2^+ solar flare are presented. Data are also presented on the solar cycle variation during non-flare sun conditions. For non-flare conditions, the x-ray emission of the sun at a sunspot maximum in the 8–20 Å region is 40 times the emission of sunspot minimum. An additional increase of at least a factor of five accompanied the class 2^+ flare. In addition during the flare an x-ray emission extending up to quantum energies of 70 kev and penetrating below 43 km was observed. The energy contained in this emission tail for quantum energies E > 20 kev was of the order of 2×10^{-5} ergs/cm^2/sec and changed noticeably in a time period of three minutes. X-ray emissions of E > 20 kev were observed in three class 2^+ flares and were not observed in a rocket equipped with identical detectors flown during non-flare solar conditions. (auth)

5911 INTERPLANETARY DYNAMICAL PROCESSES. E. N. Parker. Interscience Monographs and Texts in Physics and Astronomy. Volume VIII. New York, Interscience Publishers, 1963. 280p. $12.50.

A theory of interplanetary dynamics based on coronal expansion as the source of interplanetary gas motions is presented. The hydrodynamic equations for the solar atmosphere yield only one solution and it is used as the basis of this treatment. It assumes coronal expansion to supersonic velocities of several hundred kilometers per second far out from the sun under the throttling effect of the solar gravitational field. Observations of solar winds, solar corona and magnetic fields, and solar effects on high-energy charged particles traveling in space are discussed. The kinetic and hydrostatic properties of coronal atmosphere are also studied. Quiet-day coronal expansion and a model for quiet-day corona and solar wind are discussed. Energy transport in and sudden expansion of coronas with extension of the solar wind into space are treated. Magnetic fields and irregularities in interplanetary space are discussed. (R.E.U.)

Atomic Physics

5912 (BLG-196) MULTIPLE BEAM MOIRE PATTERNS. R. Gevers (Brussels. Centre d'Etude de l'Energie Nucléaire). Sept. 1963. 12p.

The amplitudes of the electron waves transmitted and scattered by a foil formed by the superposition of two plate-shaped parallel crystals are calculated. The N-beam case in which it is assumed that N families of lattice planes are near the exact Bragg orientation for reflection is considered. An example is discussed. (auth)

5913 (ORNL-3499(Vol.I)(p.32-3)) IONIZATION OF LITHIUM BY ELECTRONS AND PROTONS. R. G. Alsmiller, Jr. (Oak Ridge National Lab., Tenn.).

The cross section for the ionization of lithium by electrons and protons were calculated by a method introduced by Gryzinski. The values obtained are much larger than those given by the Born approximation and are probably unrealistic. (auth)

5914 (NP-13344) CONTRIBUTION A L'ETUDE DE L'EFFET COMPTON DOUBLE (THESES). (Contribution to the Study of the Double Compton Effect (thesis)). Guy Burdet (Lyon. Universite). 1963. 115p.

The cross section for the double Compton effect is established by quantum-electrodynamic calculations. A method is found for describing easily variations in the cross section as a function of the photon angular distributions and the incident energy. Polarization and infrared-divergence effects are noted. Suggestions are given for several types of experiments that might possibly display the double Compton effect, using two or three detectors. Experimental results are shown for scattering in Al, Cu, and Pt. These results are compared with the theoretical predictions. (T.F.H.)

5915 OBSERVATION OF A COHERENT PRECESSION DURING THE EXCITATION OF ATOMIC LEVELS BY PULSED ELECTRON BOMBARDMENT. Odette Nédelec, Marie-Noeel Deschizeaux, and Jean-Claude Pebay-Peyroula (Faculté des Sciences, Grenoble, France). Compt. Rend., 257: 3130-3(Nov. 18, 1963). (In French)

An experiment is described in which a pulsating-intensity electron beam is used to excite the Zeeman levels of gas atoms. The light emitted from these excited atoms is found to have a time-dependent intensity. In particular, the intensity is found to be modulated with an angular frequency equal to twice the Larmor angular frequency. This modulation is attributed to coherent precession, and the theory of the effect is shown. Results are given for excited levels in Pb and Hg. (T.F.H.)

5916 THE UNRESTRICTED HARTREE-FOCK METHOD. V. Heine. Czech. J. Phys., 13: 619-30(1963).

The unrestricted Hartree-Fock method is important for discussing several effects, including the spin density produced in the core of an atom by exchange with an unfilled valence electron shell. The method allows electrons with α and β spins to have slightly different orbitals due to the differing exchange interaction, but ignores the fact that this automatically results in gaining also some in-out correlation energy. The validity of the method must therefore be questioned, since correlation is in general the larger effect. It is shown that in atomic calculations the method gives results that are in fact correct to a good order of approximation. However, the interplay of spin polarization and correlation is such that in some molecular or other systems the method would fail. (auth)

5917 PHONON RADIATION BY UNIFORMLY MOVING CHARGED PARTICLES IN PIEZOELECTRIC SOLIDS. Raphael Tsu (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 125-30(Jan. 1964).

The rate of emission and the radiation pattern of coherent phonon radiation were obtained for a charged particle traveling along the symmetry axis of a piezoelectric crystal of hexagonal symmetry. The phonon power per unit frequency radiated by a charged particle is proportional to frequency. Macroscopic equations used in the deviation permit solution of a phonon radiation problem that otherwise would be quite complicated. (auth)

5918 ELECTRON EXTINCTION DISTANCE IN SILICON. D. R. Frankl (Univ. of Illinois, Urbana). J. Appl. Phys., 35: 217-19(Jan. 1964).

A method is described for the measurement of the extinction distance for electrons transmitted through crystals. Results for Si are in excellent agreement with dynamical diffraction theory if relativistic corrections are taken into account. (auth)

5919 CROSS SECTION OF THE ELECTRON-INDUCED 6s-6p TRANSITION IN CESIUM. L. K. Hansen (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 35: 254-5(Jan. 1964).

The cross section for the 6s-6p transition in cesium excited by electrons is calculated and compared with previous results. Calculated values of the ratio of collision strength to line strength for the induced transition and of the cesium cross section are also presented. (C.E.S.)

5920 THE THEORY OF ELECTRON SCATTERING FROM MOLECULES. III. HYDROGEN MOLECULE ION. T. Iijima and R. A. Bonham (Indiana Univ., Bloomington). J. Phys. Chem., 67: 2769-73(Dec. 1963). (TID-19567)

The total intensity of fast electrons scattered by hydrogen molecule ions was calculated by using the exact molecular wave functions as well as two approximate wave functions. The effect of binding on the intensity was illustrated by comparing the calculations with the intensity given by an independent atom model. The results of the calculations indicate that to the first Born approximation the electron scattering is not very sensitive to the shape of the charge density near the nuclei. It is also shown that the binding energy may provide a reasonable criterion for predicting how well a given wave function will describe the scattered electron intensity. (auth)

5921 ENHANCEMENT OF THE EXCITED-STATE POPULATION IN A HYDROGEN-ATOM BEAM. Archer H. Futch, Jr. and Charles C. Damm (Univ. of California, Livermore). Nucl. Fusion, 3: 124-5(June 1963). (UCRL-7344-T)

A method for enhancing the population of excited states in a hydrogen atom beam is reported which is based on charge exchange of a deuteron or proton beam with lithium vapor rather than water vapor. An experiment was conducted to show the enhancement relative to water vapor; an increase by a factor of ~3 was obtained. The excited-state population varies less than 15% over a range of beam velocities equivalent to 15 to 42 kev. (D.L.C.)

5922 LONGITUDINAL SPIN RELAXATION IN SOLID He^3. S. R. Hartmann (Columbia Univ., New York). Phys. Rev., 133: A17-25(Jan. 6, 1964).

Calculations of the spin-lattice relaxation time, T_1, for He^3 nuclei in solid He^3 are made and the results are compared with experiment. A simple heuristic argument is first used that treats the two important relaxation mechanisms — diffusion and Zeeman-exchange coupling — as effectively independent, and then a more precise calculation is made that takes into account interference effects. An expression for the exchange integral J is obtained as a function of molar volume that, compared with the experiment, indicates an effective, reduced dipolar coupling. The effect of zero point motion on the dipolar interaction is investigated and by means of a very simple lattice model, it is found to be an important (but not necessarily the major) factor. (auth)

5923 PARAMAGNETISM OF LIQUID HELIUM THREE. Louis Goldstein (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 133: A52-68(Jan. 6, 1964). (LADC-5827)

The elaboration of a theoretical model describing the paramagnetic properties of liquid He^3 throughout the region of existence of this phase is presented. The model is based on a molecular field theoretical type of approach. The ratios of the actual paramagnetic susceptibility of liquid He^3 to the one it would have if it were an ideal paramagnet are predicted to be representable through a unique function depending on the reduced temperature variable. The latter contains the characteristic temperature of the nuclear spin system, which, at the present time, is only available empirically through the susceptibility ratio data. In the susceptibility ratio-reduced temperature representation all susceptibility ratios of liquid He^3 fall on a single curve. This theoretical ratio curve describes very closely the experimental ratios up to values of the reduced temperature of 0.90 − 1.0. Beyond this range the experimental susceptibility ratios become systematically larger than the calculated ratios, the differences between them being small. Quantitative arguments are advanced that appear to explain satisfactorily these discrepancies and to indicate that the theory should be valid throughout the whole range of the natural reduced temperature variable. The spin entropy-spin susceptibility relation, established and used previously, yields, with the theoretical paramagnetism model, rigorous lower limits of the entropy, heat capacity, and expansion coefficient of the liquid throughout the region of existence of this phase. With the recent extension of the melting pressure data to quite low temperatures, the rigorous spin entropy of the liquid along the melting line allows one to estimate the entropy of the solid along the melting line and at low temperatures. Here the solid entropy turns out to be less than R ln2, per mole, yielding the temperature of its heat capacity anomaly to be below one hundredth of a degree Kelvin. The discussion of the liquid He^3-solid He^3 equilibrium, on the basis of these results, seems to render questionable any analysis of the thermal properties of the solid that ignores the existence of its nuclear spin system even at medium temperatures. A semi-quantitative description of the entropy-pressure diagram of He^3 discloses various singular characteristics of the liquid entropy along the melting line in its pressure dependence, as well as the peculiar features of the solid entropy at and around the melting pressure anomaly. (auth)

5924 SPECTROSCOPIC STUDY OF CONTROLLED PROTON IMPACT ON MOLECULAR NITROGEN. J. L. Philpot and R. H. Hughes (Univ. of Arkansas, Fayetteville). Phys. Rev., 133: A107-10(Jan. 6, 1964).

Protons of energy 5 − 130 kev were passed into molecular nitrogen gas at low pressure and the resulting radiation spectroscopically analyzed. Prominent emissions studied were: two N_{II} lines located at 5005 and 5680 Å; bands of the N_2^+ first negative band system ($B^2\Sigma - X^2\Sigma$); and two Balmer lines, H_α and H_β, formed by charge changing collisions with nitrogen molecules. Absolute cross sections for the production of these emissions were measured as a function of the energy of the incident protons. Population cross sections for the v = 0 and v = 1 levels of the $B^2\Sigma$ state of N_2^+ were obtained as well as an estimate of the level population cross section of the n = 3 and n = 4 levels of atomic hydrogen formed by charge exchange. (auth)

5925 INTERACTION OF OPTICAL AND INFRARED RADIATION WITH METASTABLE HYDROGEN ATOMS. Wolfgang Zernik (Radio Corp. of America, Princeton, N. J.). Phys. Rev., 133: A117-20(Jan. 6, 1964).

The theory of the quenching of the metastable 2S state of atomic hydrogen by means of optical radiation, for example by the light from a ruby laser, is discussed. The case discussed is that for which the incident intensity is sufficiently weak for the usual quantum-electrodynamical perturbation theory to be valid. A procedure developed by Schwartz and others is used to carry out the sum over intermediate states without explicit enumeration. The results are given for a range of incident wavelengths from 5000 Å to 50 μ. For unpolarized light from a ruby laser (6934 Å), the total cross section for quenching is found to be 1.27×10^{-22} cm^2. The cross section for coherent scattering was also calculated for the same range of wavelengths; for ruby laser light, the total cross section for scattering is found to be 1.03×10^{-23} cm^2. (auth)

5926 CORRELATION IN HELIUM-LIKE ATOMS. C. W. Ufford and Jeannette G. Thomas (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 133: A121-2(Jan. 6, 1964).

In order to test the Z dependence of Wigner's correlation potential when applied to atoms, the effect of electron correlation was calculated for the ground-state energy of helium-like atoms with Z = 1 to 10, using hydrogen-like wave functions in first order perturbation theory. The results are compared with the difference between the self-consistent field calculations and the observed values. The agreement is sufficiently good to show that this type of potential should give satisfactory results when used with a self-consistent field wave function in more complicated atoms. (auth)

5927 TRANSPORT COEFFICIENTS AND CROSS SECTIONS IN ARGON AND HYDROGEN–ARGON MIXTURES. A. G. Engelhardt and A. V. Phelps (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 133: A375-80 (Jan. 20, 1964).

Using a method described previously the distribution function of electron energies for electron in argon and mixtures of hydrogen and argon was obtained by a numerical solution of the Boltzmann equation that takes into account elastic and inelastic collisions. By taking appropriate averages over the distribution function, the electron drift velocity, magnetic drift velocity, and characteristic energy are computed. A comparison of calculated and experimental values of these transport coefficients enables one, in the case of pure argon, to extend the previous work of Frost and Phelps and derive the momentum transfer cross section from 0.7 to 25.0 ev. The momentum transfer and inelastic collision cross sections derived for argon and previously for hydrogen give rise to transport coefficients in mixtures of these two gases that are consistent with most of the available experimental data. (auth)

5928 FLUORESCENCE YIELDS OF THE L_{II} AND L_{III} SHELLS IN HEAVY ELEMENTS. R. C. Jopson, J. M. Khan, Hans Mark, C. D. Swift, and M. A. Williamson (Univ. of California, Livermore). Phys. Rev., 133: A381-4 (Jan. 20, 1964). (UCRL-7235)

A method was developed to measure the fluorescence yields of the L_{III} subshells in many heavy elements. This method is closely related to the K to L x-ray coincidence measurements used to determine ω_{KL}, the partial L shell yield following K x-ray emission. The fluorescence yield ω_{KL} is a linear combination of ω_{LII} and ω_{LIII}, the fluorescence yields of the L_{II} and L_{III} subshells. The scintillation counters used to perform the coincidence experiments cannot separate the two components ($K_{\alpha 1}$ and $K_{\alpha 2}$) of the K_α x rays, and thus the experiment determines only the average fluorescence yield ω_{KL}. There are a number of elements possessing K absorption edges between the $K_{\alpha 1}$ and $K_{\alpha 2}$ x rays of the target materials. By using one of these elements as a secondary radiator, it is possible to eliminate all pulses in the K x-ray counter due to $K_{\alpha 2}$ x rays. The only target x rays contributing to the coincidence rate are the $K_{\alpha 1}$ x rays, which are caused by $L_{III} \rightarrow K$ transitions. The observed coincidence rate is therefore proportional to $\omega_{L_{III}}$. Values of $\omega_{L_{II}}$ can then be computed using previous measurements of ω_{KL}. (auth)

5929 READJUSTMENT OF THE NEON ATOM IONIZED IN THE K SHELL BY X RAYS. Manfred O. Krause and Thomas A. Carlson (Oak Ridge National Lab., Tenn.). Phys. Rev., 133: A385-90(Jan. 20, 1964).

The distribution of neon ions that result from ionization by x rays was measured with a coincidence time-of-flight mass spectrometer. Radiation from an aluminum target, filtered through a beryllium foil, was used so that in more than 95% of the events a K electron was removed. The observed charges, including L ionization, are distributed as follows: Ne^{1+} = 3%; Ne^{2+} = 66%; Ne^{3+} = 24%; Ne^{4+} = 6%; Ne^{5+} = 0.8%. On the average 2.4 electrons are removed per interaction. The charge spectrum was also computed using calculated K-LL Auger transition rates and electron shake-off probabilities as given by the β^- decay of Ne^{23}. The assumptions of the models used as well as the applicability to the study were examined. Comparison of the calculations with the experimental data indicates the presence of other modes of ionization. (auth)

5930 Kβ EMISSION SPECTRA OF ARGON AND KCl. [PART] I. Richard D. Deslattes (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: A390-8(Jan. 20, 1964).

Measurements of the Kβ region of argon gas, and potassium and chlorine in KCl are reported. These spectra were obtained in fluorescence and recorded by means of a vacuum, two-crystal spectrometer using calcite crystals. Under high-energy fluorescent excitation, the chlorine spectrum differs only slightly from that obtained under electron bombardment. Differences, if any, in the potassium spectrum are not apparent. The argon spectrum was previously examined with sufficient resolution and intensity linearity to allow such comparison. The spectra are discussed in an attempt to clarify some of the problems associated with the chlorine valence emission band. (auth)

5931 Kβ SPECTRA OF ARGON AND KCl. II. SATELLITE EXCITATION. Richard D. Deslattes (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: A399-407(Jan. 20, 1964).

A model for double-vacancy, single-jump satellites is considered for the case of the Kβ spectra of argon, and argon-like ions. The excitation thresholds implied by this model were investigated by quasimonochromatic fluorescence for the Kβ spectrum of chlorine in KCl. Significant alterations in the spectrum, depending on the character of the primary radiation, are reported for this case. From these observations, the initial states for certain of the more prominent spectral features were identified as belonging to the configuration KM. (auth)

5932 STARK LIFETIMES FOR THE HYDROGEN ATOM. John R. Hiskes (Univ. of California, Livermore), C. Bruce Tarter, and D. A. Moody. Phys. Rev., 133: A424-6(Jan. 20, 1964). (UCRL-7088)

The radiative transition probabilities in hydrogen were calculated for all Stark transitions through n = 25. In general, the total transition probability and lifetime of a particular state are a function of the parabolic quantum numbers n_1, n_2, and m. For m > 0 and to within an error of the order of one percent the radiative lifetimes are functions only of n, m. The radiative lifetimes are presented graphically for all states from n = 2 through n = 25. (auth)

5933 ENERGY TRANSFER FROM Er^{3+} TO Tm^{3+} AND Ho^{3+} IONS IN CRYSTALS. L. F. Johnson, L. G. Van Uitert, J. J. Rubin, and R. A. Thomas (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 133: A494-8(Jan. 20, 1964).

Energy transfer from Er^{3+} to Tm^{3+} and Ho^{3+} ions in crystals was found to occur. Transfer proceeds from the $I^4_{13/2}$ state of Er^{3+} to the H^3_4 and I^6_7 emitted states of Tm^{3+} and Ho^{3+}, respectively. Phonon emission is required to conserve energy. The enhancement of infrared emission from Tm^{3+} and Ho^{3+} ions due to energy transfer from Er^{3+} results in a lowering of the threshold for maser oscillation

of Tm^{3+} and Ho^{3+} ions in $CaMoO_4$. However, results indicate that greater benefit from energy transfer can be obtained in the garnets where Tm^{3+} and Ho^{3+} emission is strengthened by two orders of magnitude. (auth)

5934 EXCITED STATES OF CESIUM HALIDE CRYSTALS. R. S. Knox (Xerox Corp., Webster, N. Y.). Phys. Rev., 133: A498-501(Jan. 20, 1964).

A model of the conduction band structure of cesium halide crystals is suggested. It combines the features of two earlier electron-transfer models by Fischer and Hilsch and by Klick and Kabler into one which, in the language of effective mass theory, amounts to requiring several, but at least three, separate conduction bands having a splitting of the order of 0.1 ev. On the basis of this model, both the fine structure of the cesium halide F bands and the unusually high multiplicity of cesium halide exciton bands can be consistently understood. Further implications of the model are discussed. (auth)

5935 FARADAY ROTATION OF RARE-EARTH IONS. I. THEORY. Y. R. Shen (Harvard Univ., Cambridge, Mass.). Phys. Rev., 133: A511-15(Jan. 20, 1964).

A general expression for the complex Faraday rotation is obtained by generalizing the Kramers-Heisenberg dispersion formula. It shows that the pure rotation is proportional to the sum of circular dichroism in all resonance transitions weighted by the appropriate resonance-dispersion factors. The cases of free ions and rare-earth ions in solids are discussed. It is shown how Gd^{3+} and Eu^{2+}, having the same electronic structure, may possess very different rotatory powers in a given frequency range through the difference in their optical spectra. The formula for the anomalous rotatory dispersion about sharp lines is also given. (auth)

5936 FARADAY ROTATION OF RARE-EARTH IONS IN CaF_2. II. EXPERIMENTS. Y. R. Shen and N. Bloembergen (Harvard Univ., Cambridge, Mass.). Phys. Rev., 133: A515-20(Jan. 20, 1964).

The complex rotatory power of several rare-earth ions in the CaF_2 lattice was observed. Measurements on anomalous rotatory dispersion and concomitant circular dichroism about some spectral lines in $CaF_2:Nd^{3+}$ and $CaF_2:Er^{3+}$ crystals agree well with theory. The rotatory power of Gd^{3+} in CaF_2 in the visible range is very small. By contrast, the rotation in (Eu^{2+}, Eu^{3+}) doped CaF_2 crystals is very large and stems from the Eu^{2+} ions. The rotatory dispersion measurements show that the strong absorption lines and bands of Eu^{2+} in the visible region are responsible for the large optical rotatory power of Eu^{2+}. Gd^{3+} and Eu^{2+} are isoelectronic in structure, but the difference in their optical spectra gives rise to a significant difference in their optical rotatory power. This assertion is supported by experimental observations. (auth)

5937 ELECTRON ATTACHMENT AND IONIZATION IN OXYGEN, CARBON MONOXIDE AND CARBON DIOXIDE. R. K. Asundi (Univ. of Sheffield, Eng.), J. D. Craggs, and M. V. Kurepa. Proc. Phys. Soc. (London), 82: 967-78 (Dec. 1, 1963).

Electron attachment and ionization cross section measurements were made under single collision conditions both by an absolute and a comparative method, and are compared with recent relevant data. The corrections employed in the latter are seen to be valid in view of the good agreement with the absolute measurements. In the absolute measurements a Tate and Smith type apparatus is used where all the ions are collected and the measurements do not involve any kinetic energy or angular discriminations. Ionization cross sections for 80-ev electrons in the three gases oxygen, carbon monoixde, and carbon dioxide are 2.76×10^{-16} cm^2, 2.93×10^{-16} cm^2, and 4.23×10^{-16} cm^2, respectively, while the peak resonance attachment cross sections resulting in the formation of O^- are 1.32×10^{-18} cm^2, 2.18×10^{-19} cm^2, 1.37×10^{-19} cm^2, and 4.44×10^{-19} cm^2 at 6.7, 10.1, 4.45, and 8.15 ev, respectively. The value 1.37×10^{-19} cm^2 at 4.45 ev corresponds to a second peak observed in carbon dioxide. Ionization potentials corresponding to the formation of positive ions and the onset potentials corresponding to the formation of negative ions in the dissociative process were determined. (auth)

5938 EFFECT OF VIRTUAL EXCITATION OF THE 2s AND 2p STATES ON THE ELASTIC SCATTERING OF ELECTRONS BY ATOMIC HYDROGEN. R. P. McEachran and P. A. Fraser (Univ. of Western Ontario, London). Proc. Phys. Soc. (London), 82: 1038-45(Dec. 1, 1963).

The elastic scattering of electrons by ground-state hydrogen atoms, for electron energies below the first threshold of excitation of the atom (10.2 ev), is investigated numerically making full allowance for exchange and for the virtual excitation of the 2s and 2p states of atomic hydrogen. Singlet and triplet phase shifts are obtained for values of the total orbital angular momentum of L = 0, 1, and 2. The results indicate the existence of very narrow resonances just below the n = 2 excitation threshold for several of the spin and angular momentum states. This work was done by an integral equation method, reported previously by Smith, McEachran, and Fraser, which explicitly allows for the damped exponential behavior of the wave functions in the asymptotic region of the closed scattering channels. The results of the present calculation are in very good agreement, except very close to the n = 2 threshold in the orbital angular momentum state L = 1, with the previously reported results of Burke and Schey who have treated this same problem by a different numerical method. (auth)

5939 CALCULATIONS IN THE VICINITY OF THE 2s, 2p THRESHOLD OF THE CROSS SECTIONS FOR THE EXCITATION OF HYDROGEN ATOMS BY ELECTRONS. R. Damburg and M. Gailitis (Inst. of Physics, Latvian Academy of Science, Riga, USSR). Proc. Phys. Soc. (London), 82: 1068-70(Dec. 1, 1963).

Calculations were carried out in the 1s–2s–2p close-coupling approximation for cross sections in the vicinity of the 2s, 2p threshold. It is shown that the cross sections Q(1s–2s) and Q(1s–2p) in the vicinity of the threshold do not tend towards zero. (auth)

5940 ELECTRON CORRELATIONS IN NARROW ENERGY BANDS. J. Hubbard (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc. (London), Ser. A, 276: 238-57(Nov. 26, 1963).

It is pointed out that one of the main effects of correlation phenomena in d- and f-bands is to give rise to behavior characteristic of the atomic or Heitler-London model. To investigate this situation a simple, approximate model for the interaction of electrons in narrow energy bands is introduced. The results of applying the Hartree–Fock approximation to this model are examined. Using a Green-function technique an approximate solution of the correlation problem for this model is obtained. This solution has the property of reducing to the exact atomic solution in the appropriate limit and to the ordinary uncorrelated band picture in the opposite limit. The condition for ferromagnetism of this solution is discussed. To clarify the physical meaning of the solution a two-electron example is examined. (auth)

5941 FIRST-ORDER EXCHANGE APPROXIMATION. K. L. Bell and B. L. Moiseiwitsch (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A, 276: 346-53(Dec. 3, 1963).

It is shown that when the Born approximation is applied to rearrangement collisions in the customary way, terms of the first order in the interaction energy between the colliding particles are omitted from the exchange scattering amplitude. If these terms are retained the arbitrariness which arises from the lack of orthogonality between the initial and final state wave functions is removed. The first-order exchange approximation derived is employed to calculate the cross sections for the 1s–2s and 1s–2p excitations of hydrogen atoms by electron impact and the elastic scattering of electrons by hydrogen atoms. (auth)

5942 DISSOCIATION OF D_2^+ IONS IN MOLECULAR REACTIONS AT 3.5 TO 100 kev. S. E. Kupriyanov, N. N. Tunitskii, and A. A. Perov. Zh. Tekhn. Fiz., 33: 1252-9 (Oct. 1963). (In Russian)

Factors influencing deuteron formation cross sections in $D_2^+ \rightarrow D^+ + D^0$ and $D_2^+ \rightarrow 2D^+$ were investigated, and mean effective cross sections for processes corresponding to molecular ion energy distribution at the excitation point were developed for 3.5 to 100 kev. (R.V.J.)

5943 FORMULA FOR ELASTIC ELECTRON SCATTERING CROSS SECTIONS. A. N. Pilyankevich (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, USSR). Zh. Tekhn. Fiz., 33: 1260-4(Oct. 1963). (In Russian)

Slater wave function approximations were used in a quantitative analysis of formulas for electron elastic scattering cross sections. The formulas were developed under an assumption of exponential screening of scattering atom Coulomb potentials. The obtained formulas cannot be used for quantitative calculations for most of atoms. (R.V.J.)

Cosmic Radiation

5944 (PAN-454/VI) DOUBLE MAXIMUM ANGULAR DISTRIBUTIONS AND ASYMMETRY IN HIGH-ENERGY NUCLEAR JETS. P. Ciok, T. Coghen, et al. (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1963. 13p.

Analysis of the composite angular distribution of secondary particles from 115 high energy jets from the ICEF emulsion stack produced by singly charged or neutral primaries confirmed the statement that the double maximum angular distribution is a general feature of strongly anisotropic, high energy jets. Evidence that some collisions lead to the emission of secondaries that could be described as isotropic emission from a single center that is moving in the center-of-mass system of colliding nucleons is noted. (auth)

5945 (PAN-460/VI) CORRELATED COUNTS OF MUON AND NUCLEON COMPONENTS DETECTORS IN E.A.S. UNDER A THICK ABSORBER. J. Hibner, R. Firkowski, J. Gawin, and A. Zawadzki (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1963. 37p.

It was found that due to the secondary interactions of nucleons producing nucleon cascades and muons producing secondary electromagnetic cascades the distribution of particles under the thick absorber is not Poissonian. Rather, the particles tend to form groupings. The deviations of the distribution of counts from the hypergeometrical distribution are given. Groupings of counts with multiplicities of 2 to 6 occur on the background of noncorrelated counts that have the hypergeometrical distribution. The results obtained show that all the groupings have the characteristic very close structure. (auth)

5946 STUDY OF THE UPPER ATMOSPHERE BY MEANS OF THE COSMOS 3 AND COSMOS 5 SATELLITES. 1. APPARATUS. Yu. I. Gal'perin and V. I. Krasovskii. Kosmich. Issled., 1: 126-31(1963).

A description is given of the particle-sensing apparatus carried on board Cosmos 3 and Cosmos 5 satellites for studies of ionospheric charged particles. Three types of counters were used, covering the energy spectrum from just above thermal up to hard particles in the high-Mev range. The indicator type counter consisted of a fluorescent screen laid on a glass base and faced with a thin aluminum foil to eliminate low-energy particles. The entire assembly was housed in a cylinder. Near the cylinder aperture were two girds, one grounded to the case and the other biased at (–)40 v to block passage of thermal electrons. The fluorescent screen was isolated from the case and could have stepped voltages applied to it of 0, 0.15, 3, 6, and 11 kv in order to segregate the penetrating electrons according to energy level. Screen illumination from particle impact was detected by a photomultiplier whose output was stored and telemetered. On each satellite five such counters were mounted in various attitudes and with differing values of phosphor composition and foil thickness. The ion trap passed both positive and negative particles above a fixed threshold level and registered their algebraic sum. This trap was a tubular cylinder with a grid arrangement similar to the indicator type. The collecting element was a silvered metal ring 0.43 cm^2 in area, whose output fed into an electrometer tube. The ring was located in the annular air gap of a permanent magnet whose field diverted any electrons arriving at less than 5 kev, as well as ions with similar Larmor radius. The ion trap thus could sense selected ranges of positive ions as well as electrons above 5 kev. Two traps were used on each satellite, one with a fixed grid bias of (–)40 v, the other with a bias of +24 v. It was determined that the spurious effect of photoemission caused by solar rays striking the collecter ring was small (on the order of 10^{-11} amp), which verified the suppressing action of the trap's magnetic field. A standard halogen-filled Geiger counter was used, which had an effective area of 4.3 cm^2 and was shielded by 3.4 g/cm^2 of lead. With the added shielding of the satellite skin this counter had a negligible response to electrons below 400 kev or protons below 50 Mev. Sample recordings of the indicator counter are given which show modulation in electron count caused both by the stepped accelerating voltages and by the rotation of the satellite. Degradation in the Al foil was detected, apparently caused by micrometeorite erosion. A large increase in foil porosity occurred during the launch phase, due either to frequent meteorite contact while rising through the denser atmospheric layers or to sudden outgassing of the foil on entering the vacuum environment. The variations and relative orientations of the indicator and trap counters are shown. (AID)

5947 STUDY OF THE UPPER ATMOSPHERE BY MEANS OF THE COSMOS 3 AND COSMOS 5 SATELLITES. 2. SOFT PARTICLES. V. I. Krasovskii, Yu. I. Gal'perin, N. V. Dzhordzhio, T. M. Mulyarchik, and A. D. Bolyunova. Kosmich. Issled., 1: 132-9(1963).

Geoactive particle research was conducted during the Cosmos 3 and Cosmos 5 orbital flights. The existence of currents of electrons and positive ions in the upper ionosphere having energies that are relatively low but greater than thermal is postulated. This was concluded from

fluxes detected by the two types of particle counters used: a sensor formed of a fluorescent screen and photomultiplier, which was biased negatively and also shielded with Al foil so as to register only electrons above 40 ev and positive ions whose free path exceeded the foil thickness (e.g., protons of the order of 200 kev), and an ion trap which registered electrons of 5 kev or more and positive ions. The trap counters showed repeated instances of anisotropic positive ion flow in a direction normal to the geomagnetic force lines; the fact that no simultaneous indications appeared in the indicator screen type counters suggests that these were "soft" positive ions; if protons, their energy would be less than 200 kev. This conclusion is supported by the fact that when the satellite had turned 180° the indicator counters in turn registered particles not sensed by the ion traps, which were evidently electrons below 5 kev. It was concluded that there are areas which exhibit local current flow, in which positive ion energies are estimated to be several dozen ev and average density is 10^8 ion/cm^2/sec/ster. These areas are in the 200- to 600-km region and tend to remain at the same earth latitudes for prolonged periods, sometimes as much as 9 hours. Additional observations were made of some high-energy particles, particularly those registered in the South Atlantic geomagnetic anomaly. It was concluded that these particles were electrons, estimated at between 50 kev and 1 Mev and at an omnidirectional density of 5×10^7/cm^2/sec. The possibility of spurious effects caused by the fields of on-board transmitting antennas, principally that of the telemetry transmitter, was rejected since no difference in electron count was noted whether the transmitters were on or off. The intensity and anisotropy of recorded electron currents agreed with earlier data from the 1958 Sputnik and from the U. S. "Injun" rocket of 1961. (AID)

5948 PRODUCTION OF HIGH ENERGY PIONS BY COSMIC RAY PARTICLES. N. L. Grigorov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1544-57(Nov. 1963). (In Russian)

Production of high-energy pions in the atmosphere as a result of various processes such as ionization and isobar ($J = T = 3/2$) and hyperon decay is considered. It is shown that these processes are not sufficient to explain the fluxes of high energy muons and γ quanta observed experimentally. The main features of the process responsible for high-energy pion production are examined. (auth)

5949 ENERGY SPECTRUM AND COMPOSITION OF THE PRIMARY COSMIC RADIATION IN THE ULTRAHIGH ENERGY REGION. S. I. Syrovatskii, Yu. A. Fomin, and G. B. Khristiansen (Lebedev Inst. of Physics, Moscow and Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1595-1602(Nov. 1963). (In Russian)

The primary energy spectrum, composition, and anisotropy coefficient of ultrahigh energy cosmic rays are calculated assuming the diffusion model of propagation of the rays in the galaxy and by taking into account fragmentation processes during diffusion from the source to the observation point. It is shown that the change of the primary energy spectrum exponent observed at energies $\sim 5 \times 10^{15}$ ev can be explained by assuming a definite dependence of the diffusion coefficient on energy and charge of the diffusing particle. It is natural to assume that this corresponds to a definite distribution of magnetic inhomogeneities (clouds) in the galaxy with respect to the size and magnetic field strength of the cloud. The calculations also show that at $E \sim 10^{17}$ ev there should be an appreciable number of protons and α particles in the primary cosmic radiation, a circumstance that does not contradict available experimental data. The cosmic ray anisotropy coefficient calculated on basis of the model under consideration is also consistent with the experimental data. (auth)

5950 GEOPHYSICAL AND ASTROPHYSICAL ASPECTS OF COSMIC RADIATION. L. I. Dorman (Lebedev Inst. of Physics, Moscow). PROGRESS IN ELEMENTARY PARTICLE AND COSMIC RAY PHYSICS. VOLUME VII. J. G. Wilson and S. A. Wouthuysen, eds. From the Series in Physics. Progr. Elem. Particle Cosmic Ray Phys., 7: 1-358(1963). New York, John Wiley & Sons, Inc., 1963. 367p. $12.50.

The relations between cosmic radiation and the terrestrial atmosphere, the geomagnetic fields, the galaxy, the interplanetary medium, and the solar wind are studied. The use of cosmic-ray data as a tool for studying astrophysics and geophysics and astrophysics (including solar physics) is discussed. Modulation of the cosmic radiation is reviewed. The propagation and generation of solar cosmic radiation are summarized. (T.F.H.)

5951 CORRELATION BETWEEN FORBUSH DECREASES OF COSMIC RADIATION AND SATELLITE DRAG. H. Debrunner and F. G. Houtermans (Universität, Bern). p.37-45 of "Space Research." New York, Interscience Publishers, 1960.

Correlations were found previously between magnetic disturbances and radio noise from the sun on one side and the drag exerted on satellites near perigee on the other. On the other hand, correlations are known between so-called Forbush decreases of cosmic radiation with magnetic disturbances and sun-spot activity. Permanent registration of the nucleonic component of cosmic radiation by means of a double Simpson-Type Neutron Monitor Pile shows several clear Forbush-events since October 1958, one of them as high up as to 15%, that are closely correlated to satellite drag data. (auth)

5952 COSMIC RAYS EMITTED BY THE SUN. A. N. Charakhchian, V. F. Tulinov, and T. N. Charakhchian (Academy of Sciences, Moscow). p.649-61 of "Space Research." New York, Interscience Publishers, 1960.

The great increases in the intensity of cosmic rays that occur in the stratosphere in northern latitudes are brought about by primary protons of solar origin. The energy of these protons is higher than 100–120 Mev. The index of the differential spectrum of the primary protons is equal to 6.0. The energy spectra of primary protons for different flares differ only slightly from each other. In all cases when major increases in cosmic rays were observed they were preceded by chromospheric flares of maximum power on the sun. Cosmic rays fall behind the chromospheric flares by more than 4–5 hours, but evidently by less than 10–15 hours. The registered flares of cosmic rays are correlated with magnetic storms, as well as with the onset and decrease of the Forbush intensity of cosmic rays on the earth. The flares of cosmic rays have a duration of about a few days. (auth)

5953 OBSERVATIONS OF AURORAL ZONE X-RAYS AND SOLAR COSMIC RAYS. Kinsey A. Anderson and Donald C. Enemark (Univ. of Iowa, Iowa City and Tekniska Högskolan, Stockholm). p.702-14 of "Space Research." New York, Interscience Publishers, 1960.

By use of scintillation counters carried by balloons to altitudes as high as 40 km it was found that in the auroral zone x-ray fluxes are present about 50% of the time, even in the apparent absence of geomagnetic disturbance. The magnitude of the x-ray fluxes is greatly variable but for the larger bursts is about 50 quanta cm^{-2} sec^{-1} above 25

kev. The parent electron energy spectrum was derived from the x-ray measurements and is found to be very steep, with a slope that decreases rapidly with energy. A series of flights made near the north magnetic pole obtained measurements on a flux of protons emitted by the sun following a large flare. Their spectrum in the 85 to 300 Mev energy range was found to be well represented by E^{-6} dE. A flight made 10 days following the flare still detected a small flux of these particles. (auth)

5954 ORIGIN AND NATURE OF THE GEOMAGNETICALLY-TRAPPED RADIATION. J. A. Van Allen (Iowa State Univ., Iowa City). p.749-50 of "Space Research." New York, Interscience Publishers, 1960.

A summary is given of the information available on the composition and energy spectrum of the particles in the inner and outer radiation belts. (auth)

5955 TERRESTRIAL CORPUSCULAR RADIATION AND COSMIC RAYS. S. N. Vernov and A. E. Chudakov (Academy of Sciences, Moscow). p.751-96 of "Space Research." New York, Interscience Publishers, 1960.

It is described how the existence of the outer radiation belt of the Earth was discovered and how the radiation composition in this belt was determined. The flux of the electrons of energy more than $0.5-1.0 \times 10^6$ ev was found to be 10^5 cm^{-2} sec^{-1} sr^{-1} the flux of the electrons of energy more than 5×10^6 ev was less than 0.1 cm^{-2} sec^{-1} sr^{-1}. It is shown that there are protons of energy 10^8 ev in the composition of the inner radiation belt. At the edge of the inner zone, in the region of geomagnetic latitudes $35-40°$ particles of low energies are found. These particles are probably electrons. The calculations showed that high-energy protons could be created by the decay of albedo neutrons. Beyond the geomagnetic field the flux of charged particles is 2 cm^{-2} sec^{-1} sr^{-1} and the mean ionizing capacity is 2.5 times higher than minimum one. The flux of photons of energy higher than 450 kev is less than 0.1 cm^{-2} sec^{-1} sr^{-1} and the flux of photons of energy higher than 45 kev is less than 3 cm^{-2} sec^{-1}. (auth)

5956 ON THE NATURE AND ORIGIN OF THE EARTH'S RADIATION BELTS. S. F. Singer (Univ. of Maryland, College Park). p.797-820 of "Space Research." New York, Interscience Publishers, 1960.

A brief historical introduction traces the ideas that led to the prediction and eventual discovery of geomagnetically trapped radiation. It is concluded that the cosmic neutron albedo theory accounts well for the inner belt. The spatial distribution of high energy protons around the earth, including their dependence on altitude and latitude, is derived. The extension of the theory gives the energy spectrum of these protons, which is also in good accord with observations. The motion of the trapped particles produces magnetic effects. The theory is well supported by direct observations. The relation of geomagnetically trapped radiation to magnetic storms is discussed. (auth)

5957 PHYSICAL STATE OF OUTER ATMOSPHERE AND THE ORIGIN OF RADIATION BELTS. T. Obayashi (Radio Research Labs., Tokyo). p.821-7 of "Space Research." New York, Interscience Publishers, 1960.

A possible mechanism trapping high-energy particles in the radiation belts surrounding the earth is proposed, taking into account the existing hydromagnetic waves in the outer atmosphere. It is shown that there are two regions where the amplitude of hydromagnetic waves and the compressibility of gas bearing magnetic field are large. Since the acceleration mechanism is operative in such regions, particles inside the regions may be raised in energy and consequently produce local inhomogeneities of hot plasma. These hot plasmas interact with the geomagnetic field and form a certain kind of magnetic bottle, in which the high-energy particles are trapped more firmly. The inner activated region is expected at the height 1,000 to 3,000 km and the outer region is of the order of 20,000 km. Although the origin of high-energy particles is possibly of injected solar particles, their concentration at particular regions may be controlled considerably by the hydromagnetic nature in the outer atmosphere. (auth)

5958 PHYSICAL PROPERTIES IN THE OUTER VAN ALLEN BELT AND THEIR RELATIONS TO THE PHENOMENA IN THE EXOSPHERE. Y. Inoue (National Defense Agency, Tokyo). p.828-40 of "Space Research." New York, Interscience Publishers, 1960.

On the basis of observed data on corpuscular radiation in the exosphere, the electron temperature and density in the outer Van Allen belt are estimated. The electron temperature is 2.4×10^{3}°K, the total electron density is 3.5×10^2 cm^{-3}, and the mean kinetic energy of electrons is 32 kev. The estimated total electron density is in precise agreement with ion-density measurements in the exosphere. The time of replacing old particles with new particles in the outer Van Allen belt is estimated to be 73 years. Electrons and protons trapped in the exosphere leak into the auroral zones as auroral particles. The estimated average flux of auroral particles is 1.4×10^6 particles cm^{-2} sec^{-1}. The total flux over the active region is 3.6×10^3 ($4\pi R^2$) particles sec^{-1}. The volume of the exosphere that contributes to the flux of auroral particles is 1.1×10^2 ($\frac{1}{3}\pi R^3$), where R is the radius of the earth. Local equilibrium is maintained between the mechanical force from the electric current and the pressure gradient. The pressure and pressure gradient are derived. (auth)

5959 RADIATION MEASUREMENTS DURING THE FLIGHT OF THE SECOND SOVIET SPACE ROCKET. S. N. Vernov, A. E. Chudakov, P. V. Vakulov, Yu. I. Logachev, and A. G. Nikolaev (Academy of Sciences, Moscow). p.845-51 of "Space Research." New York, Interscience Publishers, 1960.

The second Soviet space rocket was equipped with 4 scintillation counters and 6 gas-discharge counters, some of which were mounted outside the pressurized container. Some of the results of measurements in the distance intervals of 8,000 to 120,000 km from the center of the earth, and of 40,000 km from the moon to its surface are presented. Comparing the results with those given by the first Soviet space rocket, it appears that the intensity of radiation in the outer radiation belt is associated with solar corpuscular streams. The electron flux of energy ≥5 Mev (or of protons of energy ≥30 Mev) in this belt is everywhere less than one particle per cm^2 sec. There was no indication of a lunar belt of radiation. The upper limit of a magnetic field at the surface of the moon is 10^{-3} of the field at the earth's surface. The electron flux of energy <2 Mev in maximum yields a value of <5.10 particles per cm^2 sec. (auth)

5960 RADIATION MEASUREMENTS FROM SATELLITE 1958 EPSILON. Y. Miyazaki and H. Takeuchi (Inst. of Physical and Chemical Research, Tokyo). p.869-76 of "Space Research." New York, Interscience Publishers, 1960.

Signals telemetered from satellite 1958 Epsilon were recorded from July 29, to September 20, 1958. Altitude vs counting rate of a shielded G-M counter was obtained for the geomagnetic latitude $30-40°$ and for altitudes between 200–1,200 km. The results obtained were somewhat similar to those obtained from 1958 Alpha. An increase in

counting rate, although smaller than from 1958 Alpha, was found at altitudes between 300 and 400 km. However, contrary to the findings from 1958 Alpha, no close correlation between intensity variation and the planetary magnetic K_p index could be found from 1958 Epsilon. On August 25, the counting rate of one channel increased over the ordinary counting rate by more than an order of magnitude. (auth)

5961 MEASUREMENTS OF THE VAN ALLEN RADIATION BELTS DURING GEOMAGNETIC STORMS. R. Arnoldy, R. Hoffman, and J. R. Winckler (Univ. of Minnesota, Minneapolis). p.877-96 of "Space Research." New York, Interscience Publishers, 1960.

The Explorer VI satellite contained an integrating ion chamber and a Geiger counter with suitable sensitivity for exploring the radiation belts around the earth. From the first two week's data a contour map was constructed of the radiation regions, which appear to have shrunk considerably since previous measurements in the spring of 1959. Values of radiation intensity up to 10 r/hr were observed. During the magnetic storm of August 16th and 17th a substantial depression in the radiation zone was noted. The decrease in the number of trapped electrons during the negative phase of this storm is sufficient to produce the x radiation seen during intense auroras at balloon altitudes. Assuming that the electrons are precipitated into the atmosphere and produce the observed bremsstrahlung, the latitude of maximum precipitation is found to be at 57° geomagnetic. The balloon observation that auroral x rays are seen at Minneapolis, but not with high intensity in the auroral zone, is thus explained. Great increases in the outer zone were observed during the last ten days of August associated with high solar radio activity. (auth)

5962 MAGNETIC STORMS AND THE VAN ALLEN RADIATION BELTS: OBSERVATIONS FROM SATELLITE 1958 EPSILON (EXPLORER IV). P. Rothwell and C. E. McIlwain (Iowa State Univ., Iowa City). p.897-909 of "Space Research." New York, Interscience Publishers, 1960.

The changes in intensity of charged particles measured by Explorer IV, between 270 and 2,200 km above the earth's surface in August and September 1958, were analyzed. During magnetic storms marked decreases in the intensity of trapped charged particles were observed above about 1000 km, at the fringes of the outer Van Allen belt over North America and Australia; at lower altitudes, where little trapped radiation is usually observed, the counting rates increased underneath the outer zone at magnetically disturbed times. After the great magnetic storm of September 4-5, 1958, there was a significant increase in the average energy of particles trapped in the outer zone. No changes of intensity of particles in the inner Van Allen belt were detected during the period of observation except after nuclear explosions. It is suggested that the intensity decreases observed from Explorer IV in the outer radiation zone are due largely to increased scattering and absorption of trapped charged particles produced by atmospheric heating and expansion at fairly high latitudes during magnetic storms. The intensity increases observed at low altitudes beneath the outer zone are probably due to particles scattered down from the trapping region above. The average particle-energy increase in the outer Van Allen belt after a strong magnetic storm may be due either to injection of energetic particles from the sun into the trapping zone or to some acceleration process connected with the magnetic disturbance. The absence of noticeable intensity changes in the inner Van Allen belt argues in favor of a cosmic-ray albedo neutron rather than a solar origin of inner-zone protons, particularly since there was considerable solar activity during August and September 1958. (auth)

5963 SOFT RADIATION MEASUREMENTS ON EXPLORER VI EARTH SATELLITE. Alan Rosen, T. A. Farley, and C. P. Sonett (Space Tech. Labs., Inc., Los Angeles). p.938-50 of "Space Research." New York, Interscience Publishers, 1960.

Electrons above 200 kev and protons above 2 Mev at radial distances of 6,600 to 48,800 km were measured with a scintillation counter mounted in the Explorer VI satellite. The spatial distribution of trapped radiation in the Van Allen zones is presented by means of an isointensity plot, curves showing variations with radial distance at constant geomagnetic latitude, and curves showing variations with geomagnetic latitude at constant radial distance. A charged particle flux in excess of 10^8 particles/cm^2 sec was observed in regions of high intensity near the geomagnetic equator. Both daily fluctuations and sharp short term variations in the radiation flux were observed in the outer Van Allen region. The fluctuations are discussed in terms of magnetic storms and solar activity and certain theoretical mechanisms for the variations are mentioned. (auth)

5964 TRAPPED AND COSMIC RADIATION MEASUREMENTS FROM EXPLORER VI. C. Y. Fan, Peter Meyer, and J. A. Simpson (Univ. of Chicago). p.951-66 of "Space Research." New York, Interscience Publishers, 1960.

The satellite Explorer VI was placed in an elliptic orbit that passed through both the regions of geomagnetically trapped radiation and regions at greater distances from the earth. An instrument that measures protons ≥75 Mev (or electrons ≥13 Mev) separately from, and in the presence of, bremsstrahlung-producing trapped electrons was used to investigate three problems: the structure of the Van Allen radiation regions, and changes of structure with time, the detection of solar-flare high-energy particles, and the electromagnetic phenomenon of solar origin that leads to modulation of cosmic ray intensity. A preliminary report on these studies is given. (auth)

5965 COSMIC RAY MEASUREMENTS IN AUSTRALIA AT ROCKET ALTITUDES. D. I. Dawton (Royal Aircraft Establishment, Farnborough, Hants, Eng.), J. J. Quenby, and H. Elliot. p.967 of "Space Research." New York, Interscience Publishers, 1960.

A single Geiger counter was used to carry out a preliminary survey of the variation of cosmic ray intensity with height above Australia. The counter is halogen quenched and operates at 360 volts with an efficiency for detecting ionizing particles of 90%. The scaled pulse output was telemetered on both the upward and downward sections of the flight. The trapped radiation belt was not reached, but the cosmic ray intensity was found to increase by 65% between the altitudes 100 and 750 km. The Stormer cone giving the allowed directions for the arrival of primary particles of a given energy at a point inside the geomagnetic field varies in size with the altitude of observation. If the altitude dependence of both the Stormer cone and the geometrical shadow of the earth are taken into account, the observed increase with altitude of the cosmic ray intensity can be explained. The form of the primary spectrum assumed is a negative power law in particle magnetic rigidity. Good agreement is obtained between the observed and calculated altitude dependence when a value of 2 is used for the differential power law exponent in the 3 to 10 Bv rigidity range. (auth)

5966 THE IMPACT OF COSMIC RADIATION IN METEORITES. Johannes Geiss and Hans Oeschger (Uni-

versität, Bern). p.1071-9 of "Space Research." New York, Interscience Publishers, 1960.

From tritium contents in small stony meteorites a primary cosmic ray flux of 0.6–0.8 particles/cm^2 sec sr with E ≥ 300 Mev is calculated. Intensity variations of the cosmic radiation with time can be detected by comparison of cosmic ray produced radio-isotopes in meteorites. Radiation ages (exposure ages) of meteorites from He^3/tritium content and from other isotopes are discussed. The oldest observed radiation ages lead to an upper limit of 2×10^{-7} g/cm^2 year for the space erosion rate of iron meteorites. From this figure an upper limit of 3×10^{-22} g/cm^3 for the dust density along the path of the iron meteorites in space may be evaluated. It is shown that radiation ages of the order of 10^7 years or younger are not affected appreciably by space erosion, but rather give the time of the creation of the meteorite by a break-up process from a larger object. (auth)

Criticality Studies

5967 (ORNL-3499(Vol.I)(p.49-50)) PROMPT-NEUTRON DECAY CONSTANT VS BUCKLING FOR HYDROGEN-MODERATED 3% U^{235}-ENRICHED URANIUM. J. T. Mihalczo (Oak Ridge National Lab., Tenn.).

Prompt-neutron decay constants were measured as a function of buckling for unreflected parallelepipeds of a homogeneous mixture of 8 wt % paraffin and 92 wt % UF_4 in which the U^{235} enrichment was 3.00%. The decay constants were determined by the pulsed-neutron technique, and the buckling values were computed using the measured extrapolation distance for one size and the variation of the extrapolation distance that was obtained from S_n transport theory calculations. (auth)

5968 (ORNL-3499(Vol.I)(p.50-7)) EFFECTS OF BOROSILICATE GLASS RASCHIG RINGS ON THE CRITICALITY OF AQUEOUS URANYL NITRATE SOLUTIONS. J. T. Thomas, J. K. Fox, and E. B. Johnson (Oak Ridge National Lab., Tenn.).

The natural-boron content of the glass varied from 0.5 to 5.7 wt %, and the volume of the vessel occupied by the glass ranged from 20.9 to 30%. Results from exponential experiments, using a critical layer of solution above the column of solution-ring mixture as a neutron source, provided estimates of the material buckling of the mixture as a function of solution concentration, boron content of the glass, and the glass volume present. It was shown, for example, that the buckling is negative if glass containing 4 wt % boron occupies more than 22% of the mixture volume, whereas the same concentration of glass containing only 0.5 wt % of boron results in positive values of the buckling except for solutions more dilute than about 72 g of uranium per liter. (auth)

5969 (ORNL-3499(Vol.I)(p.58-62)) CRITICAL ARRAYS OF U(93.2) METAL CYLINDERS. J. T. Thomas (Oak Ridge National Lab., Tenn.).

Critical experiments were performed with three-dimensional arrays of individually subcritical units of U(93.2) metal with various thicknesses of paraffin reflector. The units consisted of cylinders containing about 21 and 26 kg of U(93.2) supported on stainless steel rods and separated by stainless steel spacers. In some arrays neutron-moderating materials surrounded the individual units. Within the range of the experiments, the effect of placing a 15.24-cm-thick paraffin reflector around an array of a particular density was to reduce the number of units required for criticality by a factor of ~12. The critical number was further reduced by a factor of ~2 by the addition of 1.270-cm-thick Plexiglas between adjacent units. (auth)

5970 (ORNL-3499(Vol.I)(p.62-3)) CRITICAL EXPERIMENTS AND CALCULATIONS WITH ANNULAR CYLINDERS OF U(93.2) METAL. J. T. Mihalczo (Oak Ridge National Lab., Tenn.).

Critical experiments were performed on annular cylinders of enriched (93.2% U^{235}) U metal to verify the adequacy of the S_n method of solving the transport equation for this geometry. The measured reactivities agree well with the calculated multiplication constants. Measurements of prompt-neutron decay constants by the pulsed-neutron technique were included. (auth)

5971 (ORNL-3499(Vol.I)(p.64-7)) PROMPT-NEUTRON DECAY PROPERTIES AND CRITICAL DIMENSIONS OF UNMODERATED CYLINDRICAL U(93.2) METAL ASSEMBLIES WITH LARGE GAPS. J. T. Mihalczo (Oak Ridge National Lab., Tenn.).

Unmoderated and unreflected critical experiments in which the flat surfaces of pairs of 7-, 11-, and 15-in.-diam cylindrical U(93.2% U^{235}) metal disks were separated by 0 to 9 in. yielded critical thicknesses varying from 1.625 to 3.25 in. for one member of the pair and prompt-neutron decay constants varying from 1.07×10^6 to 0.7×10^6 sec^{-1}. The adequacy of the S_n method in the S_8 approximation with the six-group cross sections of Hansen and Roach used for the calculation of these assemblies is demonstrated since the calculated multiplication factors for 11 different experimental configurations of 11-in.-diam disks are between 0.99 and 1.002. Prompt-neutron lifetimes obtained with the measured decay constants and the calculated effective delayed-neutron fractions are as much as 25% longer than those obtained for a solid assembly due to the neutron transit time over the gap. (auth)

5972 (ORNL-3499(Vol.I)(p.77-81)) APPLICATION OF MONTE CARLO CALCULATIONAL TECHNIQUES TO THE STUDY OF FAST CRITICAL ASSEMBLIES. W. E. Kinney, J. T. Mihalczo, and I. Happer (Oak Ridge National Lab., Tenn.).

Monte Carlo techniques were used to predict the multiplication constants for unmoderated, unreflected U(93.2% U^{235}) metal critical assemblies. Preliminary calculations for a sphere, a parallelepiped, and three cylinders are in agreement for the various geometries, but are about 4% higher than the measurements. (auth)

Direct Energy Conversion

Refer also to abstracts 6482 and 6490.

5973 (AD-423714) AUXILIARY POWER SYSTEMS FOR SPACECRAFT: AN ANNOTATED BIBLIOGRAPHY. Peter R. Stromer, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). May 1963. Contract AF04(695)-136. 60p. (SB-63-46)

References (135) from the 1962–1963 literature reporting research and development in auxiliary power systems for spacecraft are included. Solar and nuclear auxiliary power sources are emphasized with only a representative sampling of concepts such as magnetohydrodynamics, biochemical and hydrox fuel cells, batteries, etc. Subject and corporate source indexes are provided. (auth)

5974 (AED-C-15-02) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. KERNBATTERIEN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected

Literature According to Subject Field. Nuclear Batteries. Bibliographic Compilation). (Battelle Institut e. V., Frankfurt am Main). Sept. 1963. 127p.

Five hundred and thirty references, covering the period 1959 to 1963, on nuclear batteries are presented. Report number, author, and subject indexes are included. (M.C.G.)

5975 (GEST-2011) CHARACTERISTICS OF A THERMIONIC CONVERTER WITH A HIGH-TEMPERATURE COLLECTOR. E. Blue and J. H. Ingold (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Jan. 15, 1963. 8p.

Current-voltage characteristics of a cesium-on-tantalum thermionic converter with a collector temperature comparable to that of the emitter were obtained for a variety of electrode temperatures and cesium vapor pressures. The results show that for emitter temperatures in excess of 2000°K, power outputs of a few watts per square centimeter can be obtained when the ratio of collector temperature to emitter temperature is as high as 0.75 to 0.80, which is the required range for best performance of a radiation-cooled Carnot engine, and that at temperature ratios above 0.80 the power output is insensitive to changes in electrode spacing for ratios of spacing to electron mean free path greater than 100 at a cesium vapor pressure of 5 torr. (auth)

5976 (PWA-2164) INVESTIGATION OF MAGNETOHYDRODYNAMIC POWER GENERATION. VOLUME VI. PRELIMINARY DESIGN OF 1000 AND 250 MEGAWATT MHD GENERATORS. Final Report. (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Feb. 1963. Contract AF30(602)-2487. 131p.

The results of engineering studies and the preliminary layout designs of 250 and 1000 Mw d-c generators that are compatible with continuous wave r-f conversion systems are reported. The investigations included both analytical and design effort. The design concepts and layouts are discussed with regard to their performance capabilities from both the operational and structural viewpoints. (auth)

5977 (RTD-TDR-63-4071(Pt.I)) INVESTIGATION OF NON-THERMAL IONIZATION FOR MHD ENERGY CONVERSION. B. Hoffman and F. H. Shair (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Sept. 1963. Contract AF33(657)-8298. 200p. (AD-423909)

A theoretical and applied research program is being directed toward prolonging the lifetime of magnetohydrodynamic (MHD) energy converters by reducing the necessary operating temperatures to the range 1000 to 2000°K. The process of interest is the use of the magnetically induced electric field in the MHD generator for electrical breakdown of appropriate working fluids. Work was directed toward the use of alkali metals for Rankine (vapor) cycles (although the results are applicable to Brayton cycles with certain nuclear reactors) and alkali metal seeded noble gases for studying the basic parameters of the breakdown. (auth)

5978 OPTIMIZATION OF THE MAGNETIC TRIODE-TYPE THERMIONIC CONVERTER. Maciej Zgorzelski (Warsaw Inst. of Tech.). J. Appl. Phys., 35: 197-201(Jan. 1964).

A theoretical analysis of the efficiency of a magnetic triode thermionic converter is presented, and expressions for maximum obtainable efficiencies at given emitter temperature and collector work function are evaluated. A comparison with the thermionic vacuum diode efficiency shows similar efficiencies, but at considerably lower values of optimum current density for the triode. (auth)

5979 MAGNETOHYDRODYNAMIC GENERATION AND NUCLEAR REACTORS. J. K. Wright (Central Electricity Research Labs., Leatherhead Surrey, Eng.). Nature, 200: 948-9(Dec. 7, 1963).

Some of the problems of using a magnetohydrodynamic (MHD) generator in conjunction with a nuclear reactor are discussed. Methods of lowering the minimum operating temperature of an MHD generator are suggested. An example is presented to show that an MHD generator-reactor system operating at a very high temperature is not necessarily more efficient than an equivalent gas turbine-reactor system operating at a somewhat lower temperature. (M.C.G.)

5980 RADIONUCLIDE-BATTERIES FOR SPACE TRAVEL. Hans-Keiko Stamm (Kernforschungszentrum Karlsruhe, Ger.). Weltraumfahrt, No. 4, 101-6(1963). (In German)

The use of radioisotope-fueled thermoelectric or thermionic cells for electric energy production in space vehicles is discussed. Energy change and construction of the radionuclide batteries are described. The use of Sr^{90}, a mixture of fission products, Po^{210}, Pu^{238}, Cm^{242}, or Cm^{244} as the heat source is discussed. Generators being built or planned are described briefly. Safety studies are described. (M.C.G.)

5981 THERMAL RADIATION IN SPACE NUCLEAR ELECTRIC POWER SYSTEMS. Herman Schwartz (Lewis Research Center, Cleveland). p.289-92 of "Measurement of Thermal Radiation Properties of Solids." Washington, D. C., National Aeronautics and Space Administration, 1963.

The heat rejection temperatures for a number of space nuclear electric power plants fall within the temperature range of 450 to 1400°K. The characteristics of these power-plants and the manner in which thermal radiation properties and surfacings affect their performance are discussed. (auth)

5982 MAGNETOHYDRODYNAMIC A.C. GENERATOR. Paul F. Maeder (to Paul Levinger). U. S. Patent 3,102,224. Aug. 27, 1963. Filed Feb. 17, 1960.

The electric-power generating apparatus described operates on magnetohydrodynamic principles in which alternating current outputs are developed directly under conditions of high thermal and electrical efficiencies and in which the need for collector electrodes is obviated. An electrically conductive gas ionized at high temperature is forced through a linearly directed flow passage within an alternator structure having a linearly developed polyphase stator including a magnetic core and distributed windings. The winding distributions and interconnections and the orientation of the stator in relation to the flow passage are those which, upon excitation of the windings by appropriate polyphase signals, will generate magnetic fields extending transversely through the passage and having intensity variations which shift longitudinally of the flow passage at a high rate. When the fluid is forced through the passageway at a higher velocity than that of the shifting stator field intensity, the magnetic flux fields attending the current loops induce electrical output signals in the stator windings. Frequency of the output is fixed at a natural frequency of the apparatus, which may be established either by external capacitive reactance tuning the stator windings or by the frequency of synchronous apparatus paralleled with the stator windings. Surfaces coming in contact with the extremely hot ionized gases are formed entirely of a highly infusible lining material, which is cooled by recirculated fluids of relatively low temperature. (A.G.W.)

5983 APPARATUS FOR CONVERTING HEAT INTO ELECTRICITY. Carl E. Crouthamel and Melvin S. Foster (to U. S. Atomic Energy Commission). U. S. Patent 3,119,723. Jan. 28, 1964.

This patent shows an apparatus for converting heat to electricity. It includes a galvanic cell having an anodic metal anode, a fused salt electrolyte, and a hydrogen cathode having a diffusible metal barrier of silver–palladium alloy covered with sputtered iron on the side next to the fused electrolyte. Also shown is a regenerator for regenerating metal hydride produced by the galvanic cell into hydrogen gas and anodic metal, both of which are recycled. (AEC)

5984 METHOD FOR DIRECT CONVERSION OF HEAT ENERGY TO ELECTRIC ENERGY. I. S. Zheludev and V. A. Yurin. Russian Patent 154,625. Oct. 14, 1963. Filed July 17, 1962.

A method for direct conversion of heat to electricity by alternate heating and cooling of a pyroelectric crystal polarized in a constant electric field is described. The resulting electric charges are drawn by an electric energy receiver. To improve the efficiency of the energy converter and to secure its stable operation, the polarized crystal is irradiated beforehand with gamma rays, and the energy receiver is disconnected during heating and cooling. The receiver is connected to crystal electrodes at intervals between certain of the operations. (OTS)

Elementary Particles and Radiations

5985 (IA-854) THE SYMMETRY APPROACH TO PARTICLE PHYSICS. Y. Ne'eman (Israel. Atomic Energy Commission. Soreq Research Establishment, Nahal Soreq). July 1963. 37p.

The role of the "internal" quantum numbers is reviewed, with an emphasis on observational predictions supplied by such symmetries. Candidate strong-interaction "higher symmetries" are enumerated, and compared with experimental data. We attempt to present possible draft schemes charting particles and resonances. Symmetry-breaking theories and various theoretical conjectures with respect to the origin of symmetries are briefly surveyed. (auth)

5986 (JINR-P-1392) O VOZMOZHNOSTI GEOMETRICHESKOI INTERPRETATSII SLABYKH VZAIMODEISTVII LEPTONOV. (On a Possible Geometric Interpretation of Weak Interactions of Leptons). B. A. Arbuzov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 14p.

The possibility of interpreting weak interactions between leptons as an effect of the change in the space-time structure at distances of order of $\lambda = 6 \times 10^{-17}$ is considered. The leptons are assumed to be described by the single spinor of n-dimensional space, the surface of this space being the physical four-dimensional space. The equations of this surface are constructed in a self-consistent manner by means of the values of the spinor on it and with account of the Euclidean condition at infinity. A covariant zero-mass equation is postulated for the values of the spinor on the surface. It permits introduction of electro-magnetic interactions and describes weak interactions in the first approximation. Conditions leading to the V-A variant of weak interactions are discussed. (auth)

5987 (JINR-P-1401) OB OSOBENNOSTYAKH RESHENIYA URAVNENIYA BETE-SOLPITERA V PLOSKOSTI UGLOVOGO MOMENTA. (On the Singularities of the Solutions of the Bethe-Salpeter Equation in the Angular Momentum Plane). P. Suranyi (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 7p.

It is shown that the first singularity of the scattering amplitude in the right-hand side angular momentum plane is a standing branch point in some models of particle interactions, if the total energy of the two-particle system satisfies some inequalities. (auth)

5988 (JINR-P-1402) FOTOROZHDENIE ELEKTRONNYKH I MYUONNYKH PAR NA ELEKTRONE. (Photoproduction of Electron and Muon Pairs on Electron). G. I. Kopylov, L. A. Kulyukina, and I. V. Polubarinov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963.

Using the technique of random stars, cross sections for photoproduction of electron-positron and μ^+-μ^- pairs were calculated. All eight diagrams of the third order process γ-$e^- \rightarrow e^- + e^- + e^+$ were taken into account. The analysis of the results facilitates derivation of approximate formulas for the calculation for photon energies up to 60 Mev. (auth)

5989 (JINR-P-1403) OTSENKA SECHENIYA FOTOROZHDENIYA PAR VEKTORNYKH BOZONOV. (Estimation of the Cross Section for Photoproduction of Vector Boson Pairs). G. I. Kopylov, I. V. Polubarinov, and G. L. Semashko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 16p.

The cross sections for photoproduction of vector meson pairs on nuclei and protons are calculated by the method of random stars up to high energy region where the available approximate formulas are not applicable. The range of applicability of the obtained non-relativistic and known ultra-relativistic formulas is indicated. An approximate formula for the intermediate energy range is suggested. (auth)

5990 (JINR-P-1407) GRAFICHESKII METOD V KINEMATIKE REAKTSII S UCHASTIEM FOTONA. (Graphic Method in Kinematics of Reactions Involving a Photon). E. G. Bubelev and N. A. Chernikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 10p.

A two-particle decay is considered, one of the decay products being a photon. A simple graphic method is obtained for determining the photon momentum from the emission angle in the laboratory system. The connection between the photon emission angle in the system and in the center-of-mass system is also determined by this method, which is based on Poincare's model of Lobachevsky's space. (auth)

5991 (JINR-P-1430) OB ODNOM IZ KRITERIEV OTBORA p-p-VZANMODEISTVII V YADERNYKH EMUL'SIYAKH. (On a Selection Criterion of p-p Interactions in Nuclear Emulsions). B. P. Bannik, T. Vishki, and Do In Seb (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 6p.

The "blob" distributions were measured by their magnitude in nuclear emulsion stars. They were compared with the corresponding distributions obtained for the "blobs" due to δ-electrons and accidental overlapping of veil and background grains. The measurements showed that the "blobs" are mainly due to the recoil nuclei. The recoil

nuclei and accidental overlapping may be partially separated. (auth)

5992 (NP-13347) ETUDE DES EFFETS DE STRUCTURE HYPERFINE DANS LA CAPTURE DES MESONS-MU. APPLICATION AU CAS DU LITHIUM-6 (thesis). (Study of the Effects of Hyperfine Structure in the Capture of μ Mesons. Application to the Case of Lithium-6 (thesis)). Jean Delorme (Lyon. Université). [1962]. 72p.

The effect of hyperfine structure in the capture of μ mesons is studied and extended to transitions leading to a particular final state. The hyperfine difference $\Delta\lambda$ between states is calculated, and the matrix elements of the hyperfine structure operators in the shell model are derived. The results are then applied to the transition $Li^6 + \mu^- \rightarrow He^6 + \nu$. It is shown that this reaction has as great a hyperfine structure as μ^- capture by hydrogen. The effect is essentially due to the conservation of the angular momentum and to the predominance of orbital moment configurations totaling zero in Li^6 and He^6. (J.S.R.)

5993 (NP-13355) PRODUCTION MULTIPLE DE PARTICULES DANS LES INTÉRACTIONS À HAUTE ÉNERGIE (theses). (Multiple Production of Particles in High-Energy Interactions (thesis)). Roger Laverriere (Lyon. Université). [nd]. 113p.

The statistical theory of multiple production of particles is studied. One of the difficulties in the utilization of the statistical theory is the evolution of the "phase space element" that is connected to the density of the kinematic state. The classical methods (approximations on the kinematic conditions on the particle or on the integrations themselves) and the Monte Carlo method for the calculation of this factor are reviewed. The "Gaussian approximation" method (a simplification of the Monte Carlo method), which consists of the replacement of a complicated analytical probability expression with a Gaussian function, is studied. The practical realization of the calculation and the problems posed by the utilization of the Monte Carlo method and of a computer are discussed. The validity of the approximation method is verified. The multiple production of particles in π^--p collisions at 5 Bev was calculated. The results show that 80% of the interactions lead to final states containing only nucleons and π mesons. Strange particles (Λ, K, Σ, and Ξ) occur in 12% of the interactions. Antinucleons are produced 6% of the time and K-K pairs, 2%. The mean number of π mesons created is approximately 2.3 and the maximum number is 6. These results are in good agreement with experimental results except for antiproton production. (J.S.R.)

5994 (NYO-10716) STATISTICAL FLUCTUATIONS IN THE ENERGY LOSS OF 5.8 Mev ALPHA PARTICLES PASSING THROUGH AN ABSORBER OF VARIABLE THICKNESS (thesis). Walter Rosenzweig and Harald H. Rossi (Columbia Univ., New York. Radiological Research Lab.). Nov. 1, 1963. Contract AT(30-1)-2740. 75p.

The frequency distributions of energy losses incurred by 5.8 Mev alpha particles traversing a thin absorber of variable thickness were determined experimentally. The measurements were performed with a proportional counter designed to allow a selected portion of the counting gas to serve as the absorber. The important distinction between the amount of energy lost by the ionizing particle in a given traversal of the absorber as compared to the energy deposited in the absorber is discussed and a method described that allows the measurement of the fluctuations of both types of events. The experimental results are presented as frequency distributions of both energy loss and energy deposition for a series of operating conditions in which the average alpha-particle energy losses varied from 90.8 kev to 3.02 kev. In order to allow comparison between the experimental results and theory, the problem of counter resolution had to be examined in detail. This was done in an experimental study, utilizing monoenergetic x rays, the results of which are described. The measured energy loss distributions are compared, after properly taking into account the counter resolution, with theory. General agreement between experiment and theory is somewhat improved when a small correction is applied to the theoretical calculations. (auth)

5995 (UCRL-11068) K^* AND N^* PRODUCTION BY 1.96-Bev/c K^+ MESONS INTERACTING WITH HYDROGEN (thesis). Thomas Alphonsus O'Halloran, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 16, 1963. Contract W-7405-eng-48. 56p.

The Brookhaven National Laboratory's 20-inch hydrogen bubble chamber was exposed to a separated K^+-meson beam. Cross sections for the inelastic processes at 1.96 Bev/c are measured. The inelastic processes are dominated by the production of two resonances, the $I = \frac{1}{2}$ K-π resonance (K^*), and the $I = \frac{3}{2}$ pion-nucleon resonance (N^*). The four-particle state is dominated by the simultaneous production of these two resonances. Experimental evidence is presented that indicates that the one-pion exchange dominates this reaction for momentum transfers as high as 25 m_π^2. The observed cross section can be calculated by including a form factor in the one-pion-exchange calculations. The three-particle state is also dominated by the production of either the K^* of N^*. Production of the N^* cannot proceed via the one-pion exchange. Experimental evidence is presented that indicates that this process proceeds via the exchange of a vector meson. (auth)

5996 THE NEUTRON PROTON MASS DIFFERENCE AND ELECTRON SCATTERING EXPERIMENTS. W. N. Cottingham (Univ. of Birmingham, Eng.). Ann. Phys. (N. Y.) 25: 424-32(Dec. 1963).

Equations are derived that relate, to first order in e^2, the neutron-proton mass difference to information directly obtainable from electron scattering experiments. The equations are derived under two principal assumptions. The first that the mass difference is electromagnetic in origin. The second relates to the convergence properties of the theory. (auth)

5997 A FURTHER DISCUSSION OF STIMULATED EMISSION OF BREMSSTRAHLUNG. Dietrich Marcuse. Bell System Tech. J., 42: 415-30(Mar. 1963).

The existence of stimulated emission of bremsstrahlung was previously proved for electrons moving in the vicinity of nuclei. Estimate of the available power was given at that time. The theory is extended to the fourth order of perturbation theory, which allows the available power to be estimated from this process. It was found that the available power increase proportional to the fifth power of the frequency, and that power might be obtained in the order of one watt at a frequency of 1000 gigacycles. The oscillation condition at these high frequencies is met by the passage of many slow electrons through a dense assembly of ions or atoms. Although these conditions are uncommon, stimulated emission of bremsstrahlung may play a role at microwave frequencies in very high current semiconductor experiments. (P.C.H.)

5998 THE STRUCTURE OF THE NUCLEON. Nushan Akhababyan. Bulgar. Akad. Nauk. Fiz. Mat. Spisanie, 6: 91-7(1963).

The evolution of the physics of elementary particles over the past half-century is outlined, with particular reference

to the experiments in the 1950's by Prof. R. Hofstadter of Stanford University. It was concluded that such experiments are incapable of providing a model of the nucleon, although it is postulated that much can be expected from similar experiments involving 50 to 100 Bev and more of power. (OTS)

5999 THE RADIATIVE DECAY OF AN OMEGA PARTICLE. Yuan-pen Tai. Chung Kuo K'o Hsueh, 12: 1111-16 (1963).

Peculiarities of dispersion relations involving unstable particles are illustrated by an example. A dispersion relation for the process $\omega \rightarrow \pi + \gamma$ was obtained by analytical continuation with respect to the omega mass. With simplified assumptions, $(W_{\omega\rightarrow\pi+\gamma})/(W_{\omega\rightarrow 3\pi})$ was found to be 0.38 and $(W_{\eta\rightarrow\pi+\gamma})/(W_{\eta\rightarrow 3\pi})$ to be 25, where η was assumed to have the same quantum number as ω. The effect of the pair interaction of three pairs was included in the calculation. Also given is an estimate of the probability of the decay process $\omega \rightarrow \pi + \gamma$. Where the dispersion relations are employed, the $\omega_1\rho$ particles are treated as if they were stable, and the pole approximation is used. (OTS)

6000 POSSIBLE NEW HYPERON RESONANCES Y_1^{XXX} AND Ξ^{XXX}. Chung-shou Kao. Chung Kuo K'o Hsueh, 12: 1393-5(1963).

It is suggested that the Y^* and Y^{XX} hyperon resonances may be produced by means of the intermediate state Y^{XXX}: $K^- + P \rightarrow Y^{XXX} \rightarrow Y_0^*$ (or Y_0^{XX}) + π. Thus the isospin of the Y^{XXX} state should be T = 1; the new state is labeled Y_1^{XXX}. Unitary symmetry requires that baryons belonging to a unitary octet exhibit behavior similar to Regge behavior. similar to Regge behavior. From the slopes of the N–N^{XXX} and the $\Lambda - Y_0^{XXX}$ trajectories, it was estimated that the Regge trajectory of the Σ hyperon should appear as a resonant T = 1, s = 1, $J^P = 5+/2$ at M ≈ 1900 Mev. This resonance may be identified as Y_1^{XXX}; thus the spin parity of Y_1^{XXX} should be $J^P = 5+/2$. Since the widths of the eight $J^P = 1+/2$ baryons N, Λ, Σ, and Ξ are close to zero ($\Gamma_0 \approx 0$) and since the width Γ of a resonance is usually much smaller than its mass M, the real part and the imaginary part of the slope of the Regge trajectory are $(M^2 - M_0^2)/2$ and $1/2\ M\Gamma$, respectively, where M_0 is the mass of the $J^P = 1+/2$ baryon and M and Γ are the mass and the width of the $J^P = 5+/2$ resonance belonging to the same Regge trajectory. The existence of a resonance Ξ^{XXX} corresponding to the N^{XXX}, Y_0^{XXX}, and Y_1^{XXX} resonances is predicted, with the assignment T = 1/2, S = –2, and $J^P = 5+/2$ and belonging to the Regge trajectory of the Ξ hyperon. The mass of this resonance should be around 1985 Mev and its width close to, or slightly smaller than, the width of the Y_1^{XXX} resonance. If the Ξ^{XXX} resonance predicted does exist, it may be expected to appear in the reaction $K^- + P \rightarrow \Xi^{XXX} + K$. This Ξ^{XXX} will decay as $\Xi - \pi^+$, $\Xi - \pi^0$, $\Xi^0\pi^-$, $\Xi^0\pi^0$, $\Lambda\bar{K}^0$, ΛK^-, Σ^+K^-, $\Sigma^0\bar{K}^0$, Σ^0K^-, and $\Sigma^-\bar{K}^0$ resonances in the final stages. Since the mass of Ξ^{XXX} is much larger than that of a baryon, the Ξ^{XXX} resonance may also appear as a resonance with more than two particles in the final state (e.g., $\Xi\pi\pi$). The lowest laboratory momentum of the incident K^- meson for producing Ξ^{XXX} is 2.7 Bev/C. (OTS)

6001 DIFFERENTIAL PATH OF PHOTONS PRODUCED BY A VERY-HIGH-ENERGY ELECTRON IN A THICK TARGET. Gérard Clément (College de France, Paris). Compt. Rend., 257: 2971-3(Nov. 13, 1963). (In French)

In view of the production of a spectrum of particles by electrons of very high energy, an approximate expression is given, valid over a wide range of energies, for the differential path of photons produced by electron showers in a (supposedly infinitely thick) target. (tr-auth)

6002 TEST OF TWO ISOBARIC MODELS IN π MESON-PROTON SCATTERING AT THE $(3/2,3/2)$ RESONANCE. Tamer Becherrawy (Collège de France, Paris). Compt. Rend., 257: 3127-9(Nov. 18, 1963). (In French)

Two models for the $(3/2,3/2)$ resonance are attempted. These models permit the usual methods of field theory to be extended to the treatment of this resonance. The result for π^+-p scattering is in agreement with other theoretical calculations. (tr-auth)

6003 COMPTON EFFECT AT THE FIRST RESONANCE. Asit Bhattacharya (Collège de France, Paris). Compt. Rend., 257: 3323-6(Nov. 25, 1963). (In French)

With the aid of a model that permits the extension of usual field-theoretical methods to processes in which resonances occur, the differential Compton-effect cross section is calculated at the energy of the $(3/2,3/2)$ resonant state N*. For comparison with experiment, the value of the coupling constant γNN^* is deduced. (tr-auth)

6004 SEPARATION OF SPIN STATES OF A PARTICLE WITH MAXIMUM SPIN 2 IN V_4 AT APPROXIMATION $\lambda_1^1 = 0$. G. Marguleseu. Comun. Acad. Rep. Populare Romine, 13: 851-6(1963).

In the general nonlinear covariant theory of fusion, the separation in V_4 of equations of a particle with a maximum spin 2 was established for very weak vectorial fields ($\lambda_1^1 \approx 0$). Field equations are given for the spin state zero, and two cases of spin state 2, when the proper mass $k_2 \neq 0$ and when $k_\lambda = 0$. The form which conditions of integration take are also given by a set of equations. (OTS)

6005 ON PERIPHERAL PION-NUCLEON INTERACTIONS AT 7 Gev. J. Boehm, V. Petržílka, and M. Suk (Czechoslovak Technical Univ., Prague). Czech. J. Phys., 13: 703-9(1963).

It is shown by analyzing the π^--nucleon interactions at 7 Bev that it is possible to select events that could be described by the one-pion exchange model. Among the 169 stars with identified recoil proton that were examined, there are approximately 17 events corresponding to the scheme having a nucleon in the lower vertex only, while the maximum number of cases having a pion-nucleon system there is 84. For the second group the distribution of the mass of particles emitted in the lower vertex has its maximum in the region of the nucleon isobar mass (T = 3/2). The distribution of mass of particles emitted in the upper vertex is not in contradiction with the production of ζ and ρ mesons. The values of the square of the transferred four-momentum are distributed predominantly in the region of small values in agreement with the Salzman model. (auth)

6006 INFLUENCE OF THE WATER CONTENT OF THE AGFA-K2-EMULSION ON THE RANGE OF PROTON TRACKS. I. Hauser and M. Jatzlau (Zentralinstitut für Kernphysik, Reaktortechnik und Neutronenphysik, Rossendorf, Ger.). Exptl. Tech. Physik, 11: 360-4(1963). (In German)

In Agfa-K2 emulsions with different water contents, corresponding to 60 and 0% relative humidity, the range of 6.4-Mev protons was measured. The range difference amounted to 10 μm. The range calculated according to the formula of Barkas et al. agreed well with the measured value. The ratio of the volume change to weight change for change in the water content of the Agfa-K2 emulsion amounted to 0.842 ± 0.015 cm^3/g. (tr-auth)

6007 STATISTICAL MECHANICS OF QUANTUM SYSTEMS OF PARTICLES. David Ruelle (Inst. for Advanced Study, Princeton, N. J.). Helv. Phys. Acta, 36: 789-99 (1963).

It is shown that methods applied earlier to classical

systems may be extended to quantum systems of particles interacting by a two-body potential. In particular, using the canonical ensemble, for a large class of potentials, the existence of a limit for the free energy per particle when the system becomes infinite was proven. (auth)

6008 PION-DEUTERON DISPERSION RELATIONS IN IMPULSE APPROXIMATION. F. Kaschluhn (Humboldt-Universität, Berlin and Deutschen Akademie der Wissenschaften, Berlin). Nucl. Phys., 48: 451-69(Oct. 1963).

Dispersion relations for pion-deuteron forward scattering $\pi + D \rightarrow \pi + D$ are discussed by using the impulse approximation for the calculation of the contribution in the unphysical region that is due to the absorptive process $\pi + D \rightarrow N + N$. Special regard is taken to the anomalous situation that is investigated by explicit analytic continuation of the contribution from the absorptive process in the dispersion relations with respect to the pion mass. It is found that an anomalous logarithmic branch point and an anomalous pole appear at the same point, which coincides with that found in perturbation theory where the deuteron is treated as elementary. It turns out that the anomalous situation is only governed by the asymptotic behavior of the occurring deuteron wave functions. It is further shown that the spin-flip dispersion relation can be used for a determination of the pion-nucleon coupling constant. The value found by employing the impulse approximation for the spin-flip amplitude in the observable region of the dispersion relation agrees within 10% with that following from the corresponding pion-nucleon dispersion relation. For this agreement the consideration of the anomalous pole contribution is necessary. (auth)

6009 THE COMPLEX DIAGRAM OF THE PION-NUCLEON FORWARD SCATTERING AMPLITUDE. G. Hoehler and G. Ebel (Technische Hochschule Karlsruhe, Ger.). Nucl. Phys., 48: 479-91(Oct. 1963).

The pion-nucleon forward scattering amplitude F_b was calculated from dispersion relations and the optical theorem, using new data of the total cross sections. The results are given as diagrams that show the energy dependence of the complex vectors qF_b (q = pion momentum), the contribution of an elastic resonance being a circle in this representation. The pion-nucleon resonances and the non-resonant part of the scattering are discussed by the use of the diagrams for isospin $\frac{3}{2}$, $\frac{1}{2}$ and the charge exchange scattering amplitude. Near 900 Mev the curve for isospin $\frac{1}{2}$ has a shape similar to that belonging to the first resonance and suggests an almost elastic $J = \frac{5}{2}$ state for the third resonance. At the other maxima of the total cross sections the behavior is compatible with the existence of resonances, but there is no indication for a $T = \frac{3}{2}$ resonance at the shoulder of the total π^+p cross section near 875 Mev. In the region of the third resonance the non-resonant part cannot be described by a simple diffraction model. It is pointed out that the diagrams of the forward amplitude are useful as a meeting place of theory and experiment, being more easily accessible than the phase shifts from the side of the experiments. (auth)

6010 NEUTRON SPECTRA FROM BREAKUP OF DEUTERONS BY 14.7 Mev NEUTRONS. S. Messelt (Univ. of Oslo). Nucl. Phys., 48: 512-16(Oct. 1963).

Neutron spectra from the D(n,p)2n reaction at 14.7 Mev were measured at 10, 13, 16, 20, and 28° by the time-of-flight method. At 10 to 20° a low energy peak is indicated, while at 28° the measured spectrum appears nearly uniform. The results are in good agreement with a recently published measurement at 20°, but show large deviations from theoretically predicted values. (auth)

6011 HYPERCHARGE INDEPENDENCE, RESONANCES AND HIGH-ENERGY ELASTIC SCATTERING CROSS-SECTIONS. V. S. Mathur and R. P. Saxena (Univ. of Delhi). Nucl. Phys., 48: 519-23(Oct. 1963).

Hypercharge independence of electromagnetic interactions is used for developing a classification scheme for the newly discovered resonances. From the conjecture that the photon is an elementary particle rather than a Regge-pole, relations between high-energy elastic scattering cross-sections are deduced. The high-energy limit theorems of Pomeranchuk and Gell-Mann are shown to follow as a consequence. (auth)

6012 SOME RESULTS ON WEAK INTERACTIONS. Pierre Hillion (Institut Henri Poincaré, Paris). Nucl. Phys., 48: 545-54(Nov. 1963).

A theory characterizing weak interactions by their invariance under the W-R_3 group (a rotation group whose domain is the isospace $\mathfrak{K}(R_3^9)$) is applied to the calculation of some branching ratios. The results are in good agreement with recent experimental results. (auth)

6013 ON THE MICROSCOPIC THEORY OF CHERENKOV RADIATION. F. Henin (Brussels Free Univ.). Phys. Letters, 7: 193-4(Nov. 15, 1963).

The phenomenological theory of Cherenkov radiation was investigated. Both the motion of the particle responsible for the Cherenkov emission and the refractive properties of the medium through which this particle travels are given. The Maxwell equations are solved, and the energy lost by the particle is computed. (C.E.S.)

6014 HIGH ENERGY p-p AND π-p SCATTERING IN SERBER'S MODEL. H. H. Aly, D. Lurie, and S. Rosendorff (Univ. of Rochester, N. Y.). Phys. Letters, 7: 198-200 (Nov. 15, 1963).

The predictions of Serber's optical model for a purely imaginary Yukawa potential are compared with experimental high energy data for p-p and $\pi^{\pm}$-p scattering. It is shown that a superposition of two Yukawa potentials gives a significantly better fit to the experimental data than a simple Yukawa potential. (C.E.S.)

6015 HIGH ENERGY SCATTERING FROM FIELD THEORY. J. G. Taylor (Churchill Coll., Cambridge, Eng.). Phys. Letters, 7: 206-8(Nov. 15, 1963).

Field theory is used to explain the constant width of the forward diffraction peak in elastic $\pi^{\pm}$-p scattering over the momentum range 3-20 Bev/c. Coupled sets of nonlinear equations relating the off-mass shell S-matrix elements are used. Predictions are also made concerning the high energy total cross sections for $K^{\pm}$-p, π-π, p-p, and p-$\bar{p}$ scattering. (C.E.S.)

6016 POSSIBLE UNITARY SYMMETRY PROPERTIES OF THE INTERMEDIATE BOSONS AND THEIR INTERACTIONS. B. D'Espagnat (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France and CERN, Geneva). Phys. Letters, 7: 209-10(Nov. 15, 1963).

Three models that indicate possible unitary symmetry properties of intermediate bosons and their interactions are discussed. (C.E.S.)

6017 PRODUCTION PROCESSES AND MOVING REGGE CUTS. J. C. Polkinghorne (Cambridge Univ., Eng.). Phys. Letters, 7: 217-18(Nov. 15, 1963).

It is shown that cuts in the angular momentum plane on the physical sheet arise from the insertion of a double Regge pole associated with a production process. (C.E.S.)

6018 BOSON COUPLINGS AND HIGHER SYMMETRIES. H. J. Lipkin (Argonne National Lab., Ill.). Phys. Letters, 7: 221-2(Nov. 15, 1963).

Symmetry groups G_2 and SU_3 are compared with respect to boson couplings. (C.E.S.)

6019 DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $p + p \rightarrow \pi^+ + d$ BETWEEN 2.1 AND 8.9 Gev/c. G. Cocconi, E. Lillethun, J. P. Scanlon, C. A. Stahlbrandt, C. C. Ting, J. Walters, and A. M. Wetherell (CERN, Geneva). Phys. Letters, 7: 222-4(Nov. 15, 1963).

Differential cross sections are presented for the reaction $p + p \rightarrow \pi^+ + d$ at incident momenta of 2.1, 3.6, 4.1, 4.5, 6.6, and 8.9 Bev/c and deuteron emission angle of 60 mrad. Explanations are proposed for the sharp peak observed in the cross section. (C.E.S.)

6020 DETERMINATION OF A PERTURBING POTENTIAL FROM ITS SCATTERING PHASE SHIFT AND BOUND STATES ENERGY LEVELS. Egil A. Hylleraas (Univ. of Oslo). Phys. Math. Univ. Oslo Inst. Rept., No. 19, 31p. (1963). (ARL-63-216)

Considering the phase shifts $\xi_l(k)$, with $0 \leq k \leq \infty$ and $l = 0,1,2\ldots$, the problem of finding a potential function $U(r)$ reproducing $\xi_l(k)$ is studied. For simplicity, only S-wave scattering for $l = 0$ is considered. Bound states are fully taken into account. (T.F.H.)

6021 ALPHA-PARTICLE RESONANCE. Carl Werntz (Catholic Univ. of America, Washington, D. C.). Phys. Rev., 133: B19-24(Jan. 13, 1964).

A phase-shift analysis of the elastic p-t cross section in the energy range 0.1 to 0.76 Mev was made. It is shown that the low peak observed at 0.3 Mev is consistent with a 0^+ resonance at 0.5 ± 0.1 Mev. The shape of the observed cusp in the p-t elastic cross section at the threshold energy of the n-He^3 channel is used to demonstrate that the energy behavior of the singlet and triplet s-wave phase obtained must be qualitatively unique. A direct comparison is made of the Breit-Wigner single-level approximation and the alternative two-channel scattering length description of the state. (auth)

6022 CERTAIN QUESTIONS OF CONSISTENCY IN S-MATRIX THEORY. A. P. Balachandran (Univ. of California, Berkeley). Phys. Rev., 133: B68-70(Jan. 13, 1964). (UCRL-10931)

Certain questions of consistency in S-matrix theory arising from unitarity, analyticity, and crossing symmetry requirements are examined in a few special instances for two-body scattering amplitudes. It is proved that at least in these cases, the formalism does not lead to any contradiction. (auth)

6023 SIX-FERMION WEAK INTERACTIONS. Torleif Ericson (CERN, Geneva) and S. L. Glashow. Phys. Rev., 133: B130-1(Jan. 13, 1964).

Six-fermion weak interactions, in addition to the usual four-fermion weak interactions, may exist. Limits on the strength of such interactions deduced from low-energy decay phenomena are not sufficient to exclude observable effects on six-fermion couplings at high energies. In particular, the process $\nu + p \rightarrow \nu + \mu + \bar{e} + p$ may be attributed either to six-fermion couplings, or to the existence of intermediary vector bosons. (auth)

6024 EXCHANGE-CURRENT CONTRIBUTION TO THE DEUTERON MAGNETIC MOMENT. David R. Harrington (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: B142-4(Jan. 13, 1964).

An estimate is made of the contribution to the deuteron magnetic moment from an exchange-current diagram containing the $\rho\pi\gamma$ vertex. The result is sensitive to the form of the deuteron wave function at small distances: Using Hulthén and repulsive core wave functions, contributions of 0.11 and 0.01 nm, respectively, are obtained. (auth)

6025 ELEMENTARY PARTICLES OF CONVENTIONAL FIELD THEORY AS REGGE POLES. [PART] III. M. Gell-Mann (Massachusetts Inst. of Tech., Cambridge), M. L. Goldberger, F. E. Low, E. Marx, and F. Zachariasen. Phys. Rev., 133: B145-60(Jan. 13, 1964).

It is shown that an elementary particle of conventional field theory may, under certain conditions, lie on a Regge trajectory. These conditions are that the system contain a nonsense channel at the angular momentum of the particle and that the Born approximation scattering amplitude factor in a well-defined way. They are satisfied by a spin $\frac{1}{2}$ fermion interacting through a conserved current with a spin-one neutral boson. The particle in question is the fermion. (auth)

6026 ELEMENTARY PARTICLES OF CONVENTIONAL FIELD THEORY AS REGGE POLES. [PART] IV. M. Gell-Mann (Massachusetts Inst. of Tech., Cambridge). M. L. Goldberger, F. E. Low, V. Singh, and F. Zachariasen. Phys. Rev., 133: B161-74(Jan. 13, 1964).

The usual field theory of spin 0 nucleons coupled to vector mesons (or heavy photons) is studied in order to find out whether the nucleon lies on a Regge trajectory. Photon-nucleon scattering is examined, to each order in the coupling constant, with the highest power of $\ln \cos \theta$ retained. It is found that a suitable Regge trajectory is generated, but that the nucleon does not lie on it. The nucleon pole term in the scattering amplitude corresponds to a fixed singularity in angular momentum. The spin 0 nucleon thus behaves differently from a particle of spin. (auth)

6027 PRODUCTION OF A STRANGENESS –3 BARYON IN ANTIPROTON-DEUTERIUM AND K^--PROTON COLLISIONS. Saul Barshay (Brandeis Univ., Waltham, Mass. and Rutgers State Univ., New Brunswick, N. J.). Phys. Rev., 133: B175-8(Jan. 13, 1964).

Theoretical estimates are given for the production cross sections for a strangeness –3 baryon with spin-parity $\frac{3}{2}^+$ and mass of about 1.7 Bev, denoted by Ω^-, in the reactions: (1) $\bar{p} + D \rightarrow \Omega^- + K^+ + K^0 + K^0$ and (2) $K^- + p \rightarrow \Omega^- + K^+ + K^0$. For 2.8-Bev/c antiproton laboratory momentum, a lower limit is obtained on the cross section for the first reaction of about 0.01 μb. The ratio of Ω^- to Ξ^- production in antiproton-deuteron collisions is computed and it is found to be about 1% at the above momentum. For 3.5-Bev/c K^- laboratory momentum a cross section for reaction (2) of about 0.1 μb is obtained. (auth)

6028 COMPOSITE PARTICLE MODEL FOR THE NUCLEON AND THE (3,3) RESONANCE. J. S. Ball and D. Y. Wong (Univ. of California, San Diego). Phys. Rev., 133: B179-85(Jan. 13, 1964).

Partial-wave dispersion relations are used with interaction terms arising from the exchange of a nucleon, the N* and the ρ meson to produce integral equations for the partial-wave amplitudes for pion-nucleon scattering. The solutions of these equations depend on a single arbitrary parameter, the energy at which the dispersion integrals are "cutoff." It is shown that when the value of the cutoff is adjusted to produce the N* at the correct energy, a bound state, the nucleon, appears in the p wave, $I = J = \frac{1}{2}$ amplitude. Thus, the nucleon mass, the pion-nucleon coupling constant, the width of the N*, and mass of the N* are all determined by the cutoff parameter. It is shown that when the N* mass has the experimental value the other quantities are in reasonable agreement with experiment. The effect of variations in the coupling constants controlling

the interaction terms is also studied. In each case all of the $J \leq \frac{3}{2}$ partial-wave amplitudes are calculated and compared with experiment. (auth)

6029 COUPLING CONSTANT AND P-WAVE PHASE SHIFTS IN LOW-ENERGY PION-NUCLEON SCATTERING. Archibald W. Hendry and Berthold Stech (Univ. of California, San Diego). Phys. Rev., 133: B191-5(Jan. 13, 1964).

By means of a model for low-energy pion-nucleon scattering, it is shown that analyticity, unitarity, and the crossing properties are sufficiently strong conditions to determine the πN coupling constant, the P-wave phase shifts [including the position and width of the $(\frac{3}{2},\frac{3}{2})$ resonance] and to give restrictions on the $\pi\pi$ cut. In addition, the solution for the $(\frac{1}{2},\frac{1}{2})$ scattering amplitude turns out to be of the form describing the nucleon as a bound state of the πN system in close analogy to a bound state in potential theory. In the model, the $\pi\pi$ cut is represented by a pair of conjugate poles, and crossing is approximated by the static crossing relations. No cutoff parameter has to be introduced, and the crossing relations are fulfilled to a high degree. (auth)

6030 INTERPRETATION OF THE NORMALIZABLE STATE IN THE LEE MODEL WITH FORM FACTOR. L. Fonda, G. C. Ghirardi, and A. Rimini (Università, Parma, Italy; Istituto Nazionale di Fisica Nucleare, Parma, Italy; and Università, Trieste, Italy). Phys. Rev., 133: B196-203(Jan. 13, 1964).

It is found that in the Lee model with cutoff function, both bound state and resonances can be simultaneously present. The interpretation of the bound state as the physical V particle is discussed. It is made plausible that the bound state in certain cases is a composite particle. (auth)

6031 THEOREM ON THE PRODUCT OF FIELD OPERATORS. K. Nishijima (Brookhaven National Lab., Upton, N. Y. and Univ. of Illinois, Urbana). Phys. Rev., 133: B204-8(Jan. 13, 1964).

The method of constructing a local field operator for a composite particle, developed by Haag, Nishijima, and Zimmermann, is applied to an elementary particle field. It is shown that the HNZ construction as applied to a simple Lagrangian theory reproduces the original field operator. (auth)

6032 PERTURBATION-THEORETICAL INTEGRAL REPRESENTATION AND THE HIGH-ENERGY BEHAVIOR OF THE SCATTERING AMPLITUDE. Noboru Nakanishi (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B214-19(Jan. 13, 1964).

The high-energy behavior of the scattering amplitude is investigated in detail in the ladder approximation by means of the perturbation-theoretical integral representation. It is shown that this representation without subtraction is very useful and can describe the Regge behavior. The main results of the multiperipheral model are reproduced in this approach, and its connection with the Regge pole is clarified in an elegant way. It is also pointed out that one can by no means exclude the possibility of non-Regge behavior in the ladder approximation, at least within this technique. (auth)

6033 STUDY OF THE REACTION $K^+ + p \rightarrow K^0 + \pi^+ + p$ AT 1.14 Gev/c. E. Boldt (College de France, Paris), J. Duboc, N. H. Duong, P. Eberhard, R. George, V. P. Henri, F. Levy, J. Poyen, M. Pripstein, J. Crussard, and A. Tran. Phys. Rev., 133: B220-31(Jan. 13, 1964).

The inelastic process $K^+p \rightarrow K^0\pi^+p$ at 1.14 Bev/c [E_{lab}(c.m.) = 1.859 Bev]. The study was done using a hydrogen bubble chamber and analyzing events having a V^0 two-prong topology in the chamber. The total cross section for the reaction is 4.6 ± 0.3 mb. The reaction is dominated by the production of the N^*_{33} and K^* (888 Mev) resonances. The nonresonating background, if any, contributes less than 0.6 mb to the total cross section. No events were found with two pions in the final state. The cross section for N^*_{33} production is 3.6 ± 0.5 mb. The K^* production cross section (apart from possible interference contributions) is 0.9 ± 0.3 mb. The measured value for the mass of the N^*_{33} resonance is 1212 ± 8 Mev with a full width of 72 ± 13 Mev. A systematic analysis of the production and decay properties of the N^*_{33} was made. The N^*_{33} is produced with a pronounced spin alignment. The data are consistent with a complete alignment of $\pm\frac{1}{2}$ with respect to the production plane normal or with an alignment of $\pm\frac{3}{2}$ with respect to some direction in the production plane, the most probable direction being the direction of the incident K^+. No evidence is seen for the existence of the K^* (730 Mev) resonance. (auth)

6034 SYSTEMATIC SOLUTION OF MULTIPARTICLE SCATTERING PROBLEMS. Steven Weinberg (Univ. of California, Berkeley). Phys. Rev., 133: B232-?(Jan. 13, 1964).

Scattering problems for three or more particles cannot be solved by a direct use of those techniques, like the Fredholm or quasiparticle methods, that work for two particles. The trouble is that the kernel $[W - H_0]^{-1} V$ of the Lippmann-Schwinger integral equation is not L^2, even for complex W. In fact, this kernel has a continuous spectrum, giving rise to cuts in the coupling-constant plane for multiparticle scattering amplitudes. It is shown how to overcome this difficulty and calculate all Green's functions and scattering amplitudes in a systematic and essentially rigorous manner. The dynamical equations are rewritten as a sequence of linear integral equations for successively larger systems, each with a kernel and inhomogeneous term that can be calculated explicitly from the solutions of the previous equations. The kernels are L^2 because they arise from connected graphs only, so each integral equation can be solved by the Fredholm quasiparticle, or other methods. The distorted wave approximation appears very naturally in this approach. One minor by-product is an explicit upper bound on the binding energy of any N-particle composite system with square-integrable potentials. A mathematical Appendix on relevant topics in functional analysis is provided. (auth)

6035 SEPARATION OF MOTIONS OF MANY-BODY SYSTEMS INTO DYNAMICALLY INDEPENDENT PARTS BY PROJECTION ONTO EQUILIBRIUM VARIETIES IN PHASE SPACE. [PART] I. D. Bohm (Birkbeck Coll., London) and G. Carmi. Phys. Rev., 133: A319-31(Jan. 20, 1964).

Conclusions are drawn concerning the over-all dynamical properties of a many-body system. This is done without trying to solve the equations of motion, but rather, on the basis of the knowledge of oscillatory or collective variables (or more generally, from the existence of conservation rules and of the uniform constants of the motion). The main result is that, corresponding to the collective coordinates (or the uniform constants of the motion) there exists a separation of the motions into two parts, one of which is collective or oscillatory, and regular, and the other of which is noncollective, nonoscillatory, and irregular. This separation is obtained by a (canonically invariant) method of projections in phase space, from the actual phase point x^i, p_i along a certain line, which is the direction of a pure de-

excitation of an oscillation, down to a certain projected point X^i, P_i, which is the intersection of the line with an equilibrium subspace (or variety), the latter consisting of all the points in the phase space for which the collective excitation is zero. This separation is applied to an illustrative example consisting of a simple two-dimensional model, possessing all the essential features of the general problem under discussion. The results corresponding to the Bohm-Pines theory, as applied to this case, are obtained in a very simple way, without the introduction of supernumerary variables or subsidiary conditions. Instead of subsidiary conditions, a corresponding number of identities among the projected motions X^i, P_i are obtained, so that in effect, X^i, P_i, together with the collective oscillatory variables, span a space of 6N dimensions (where N is the number of particles). This definition of the X^i, P_i replaces the two canonical transformations of Bohm-Pines, and is equivalent to a certain noncanonical transformation, which removes the collective part of the motion. The method may also be regarded as a systematic generalization of that of Tomonaga; firstly, being an extension of the latter's method from configuration space to phase space, and to collective variables that are momentum dependent, and secondly, being the development of a general separation method for arbitrary variables, which contains Tomonaga's Taylor expansion of the hamiltonian as a special case. The projection method associates to each actual motion $x^i(t)$, $p_i(t)$ a unique equilibrium motion $X^i(t)$, $P_i(t)$, about which it oscillates. This association is such that, from the very way in which it is defined, the possibility of an indefinitely large increase of $\delta x^i = x^i - X^i$, $\delta p_i = p_i - P_i$ with time is avoided, so that the δx^i, δp_i, will oscillate stably in every order of approximation, without the need for special precautions to avoid secular terms, as is necessary in the usual perturbation treatments. (auth)

6036 SEPARATION OF MOTIONS OF MANY-BODY SYSTEMS INTO DYNAMICALLY INDEPENDENT PARTS BY PROJECTION ONTO EQUILIBRIUM VARIETIES IN PHASE SPACE. [PART] II. G. Carmi (Yeshiva Univ., New York) and D. Bohm. Phys. Rev., 133: A332-50 (Jan. 20, 1964).

A condensed notation in phase space that facilitates calculations is developed. With the aid of this notation, the results are given a simple geometrical interpretation in phase space by introducing a certain canonically invariant metrical tensor O_{ij}. This tensor does not yield the usual orthogonal or pseudo-orthogonal metric, but rather, what is called a symplectic metric. One then sees that the projections that are made are orthogonal, in the symplectic sense, to the equilibrium varieties. Likewise, one can see quite generally, that the entire canonical formalism, including the Poisson brackets and the hamiltonian equations of motion, reduces to simple geometrical relations in phase space, the form of which is suggestive for possible further developments, especially with regard to the treatment in higher approximations. The ideas are applied to the electron gas, and the dynamics of the plasma are illustrated with the aid of a comparison with a simple two-dimensional model, possessing all the essential features described above. In this way, one can understand many of the basic features of the plasma motions, in terms of concepts such as the generalization of the notion of centrifugal force and Coriolis force to phase space. By going over to a local geodetic frame in the equilibrium variety, one is led in a natural way to the concept of a set of quasiparticles for the plasma. If the number of collective oscillatory coordinates is s, then there will be 3N−s of these quasiparticle coordinates. The latter do not represent any of the actual original particles out of which the system is constituted, but rather, they represent effective pulse-like distributions of charge, which move together in a correlated way so as to resemble an actual particle in many respects. (auth)

6037 ANALYSIS OF p-NUCLEON INTERACTIONS PRODUCED AT AN ENERGY OF 10^{10} ev IN NUCLEAR PHOTOEMULSION. E. G. Boos, Zh. S. Takibayev, V. A. Botvin, I. Ya. Chasnikov, and N. P. Pavlova. Tr. Inst. Yadern. Fiz., Akad Nauk Kaz. SSR, 5: 16-32(1962).

A method of finding the angular and energy characteristics of nuclear disintegrations, based on the calculation of the distribution of transverse momentum of secondary particles was developed. For all identifiable particles the method gives closer agreement with experiment than other methods of approximation. The degree of anisotropy of the angular distribution of shower particles in the center-of-mass system (CMS) for a Lorentz-factor (γ_c) of 2.4 decreased with increasing multiplicity; for 3- and 8-ray stars there was an appreciable asymmetry in forward and backward emission of particles. In the region of average multiplicity (between 3 and 8) the best agreement with the expected value $\gamma_c = 2.4$ was shown by a quantity found by a kinematic method which assumes a uniform distribution of the transverse momenta of shower particles. The assumption $\beta_c/\beta_i' = 1$ (β_c is the velocity of the center-of-mass with respect to laboratory coordinates (LC), β_i' is the velocity of the particles in CMS) led to a systematic overestimate of the energy by a factor of two. Regardless of the method of estimation, γ_c for 3-ray stars was too high, while γ_c for 8-ray stars was too low; therefore the Lorentz-factor of the system where angular symmetry of the secondary particles is assumed, decreases as the multiplicity increases. As the multiplicity increased, the fraction of the energy carried off by charged meson increased both in LC and CMS, but the fraction of the energy per meson was almost unchanged (about 17%); therefore $n_{\pi^0}/n_{\pi^\pm} < 0.5$ for 7- and 8-ray stars provided that the energy spectra $n_{\pi^0}/n_{\pi^\pm}$ of π^0 and $\pi^\pm$-mesons are identical. The mass of the target also increased with the multiplicity, but it did not exceed the mass of nucleon; this confirmed the criteria for the selection of n-n-interactions. (OTS)

6038 INVESTIGATION OF LOW ENERGY $\pi^+\pi^-$ INTERACTION BY THE CHEW AND LOW METHOD. Yu. A. Batusov, S. A. Bunyatov, Ying-seb To, V. M. Sidorov, and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 913-20(Oct. 1963). (In Russian)

The $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ reaction in the 210- to 310-Mev range is analyzed. For events involving small momentum transfer to nucleons, the experimental data are linearly extrapolated to the nonphysical region by the Chew and Low method. The $\pi^+ + \pi^- \rightarrow \pi^+ + \pi^-$ elastic scattering cross section for $\omega^2 = 4-7$ obtained by linear extrapolation is 34 ± 9 mb. (auth)

6039 ASYMPTOTIC EXPRESSION FOR THE TOTAL $\gamma\gamma$-SCATTERING CROSS SECTION AT HIGH ENERGIES. V. D. Mur (Moscow Inst. of Engineering Physics). Zh. Eksperim. i Teor. Fiz., 45: 1051-9(Oct. 1963). (In Russian)

It is shown that the requirement of a nonvanishing total cross section for high-energy scattering treated by the complex moment method entails the necessity of introduction of a third order pole at the point J = 1 when t = 0 for partial amplitudes combining with a P pole. For this case an arrangement of singularities of the indicated amplitudes

is suggested that yields a maximal interaction force consistent with unitarity and analyticity and that leads to total and elastic cross sections that increase at high energies. (auth)

6040 ON PROCESSES DETERMINED BY FERMION REGGE POLES. V. Gribov, L. Okun', and I. Pomeranchuk (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1114-22(Oct. 1963). (In Russian)

The π N scattering at high energies and angles close to 180° is considered. Scattering in these conditions is assumed to be described by fermion Regge poles. A simple proof is presented that the amplitude is defined by pairs of complex-conjugated Regge poles. Polarization phenomena are investigated for one and two pairs of poles. Three types of relations (crossing, factorization, and isotopic), between cross sections of various processes due to the same Regge poles are considered. (auth)

6041 ON THE RADIATIVE ATTENUATION THEORY OF RADIAL OSCILLATIONS OF AN ELECTRON IN A MAGNETIC FIELD. S. A. Kheifets and Yu. F. Orlov (Inst. of Physics, Erivan). Zh. Eksperim. i Teor. Fiz., 45: 1125-9(Oct. 1963). (In Russian)

It is demonstrated that the formulas for the radiative attenuation decrements of an electron in an inhomogeneous magnetic field are the same when calculated by quantum or classical theory. The proof is performed for a nonrelativistic electron in a field with weak inhomogeneities with an accuracy to terms of the order of v^2/c^2. (auth)

6042 PHENOMENOLOGICAL ANALYSIS OF pp-INTERACTION AT 657 Mev. [PART] I. L. S. Azhgirei, N. P. Klepikov, Yu. P. Kumekin, M. G. Meshcheryakov, S. B. Nurushev, and G. D. Stoletov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1174-82(Oct. 1963). (In Russian)

Available data on pp interactions near 660 Mev including results of measurements of the inelastic polarization and depolarization differential cross sections, triple scattering parameters R and A, spin correlation parameters C_{KP} and C_{nn} total pp interaction cross section, and also the total cross sections for the reactions $pp \rightarrow \pi^+pn$, $pp \rightarrow \pi^+d$, and $pp \rightarrow \pi^0pp$ are subjected to phase-shift analysis. The statistically best set is obtained for real parts of the phase shifts and absorption coefficients. The real parts of the phase shifts thus found can be smoothly connected with the corresponding YLAM solution. It is found that in accordance with the peripheral model of inelastic processes, ^3F-states significantly contribute to π-meson production. (auth)

6043 ABSORPTION OF ELECTROMAGNETIC WAVES BY NEUTRINOS. V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1183-7(Oct. 1963). (In Russian)

It is demonstrated that electromagnetic waves in a medium may be absorbed by neutrinos. The absorption cross section is of a resonance nature near the proper frequencies of the medium. The possibility of observing absorption of electromagnetic waves on neutrinos is analyzed. (auth)

6044 THE $\pi + N \rightarrow \gamma + N$ REACTION AND THE CONSTANT FOR PHOTOPRODUCTION OF π-MESONS ON π-MESONS. V. A. Meshcheryakov, L. L. Nemenov, and L. D. Solov'ev (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1188-91(Oct. 1963). (In Russian)

The problem of determination of the π-meson on π-meson photoproduction constant by analyzing the $\pi + N \rightarrow \pi + \gamma + N$ reaction is considered. The differential cross sections for this reaction are calculated in the pole approximation. (auth)

6045 RELATION BETWEEN THE TOTAL CROSS SECTIONS FOR THE $\frac{1}{2} + \frac{1}{2} \rightarrow 0 + 0$ REACTION WITH THE INTRINSIC PARTICLE PARITIES. S. M. Bilenkii and R. M. Ryndin (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1192-5 (Oct. 1963). (In Russian)

Reactions of the type $\frac{1}{2} + \frac{1}{2} \rightarrow 0 + 0$ are considered. It is shown that the coefficient before (P_0P) in the expression for the total cross section of the reaction with polarized particles (P_0 and P are the beam and target polarizations) is positive if the product of the intrinsic parities is -1 and negative otherwise. This property of the total cross sections can be employed for determining the parities of strange particles. (auth)

6046 REGGE NARROWING OF THE DIFFRACTION CONE AND THE ROLE OF MULTIMESON INTERACTIONS. E. L. Feinberg and D. S. Chernavskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1252-9(Oct. 1963). (In Russian)

Elastic p-p and π-p high-energy interactions are considered. A definite regularity in the experimental results can be discerned. If the inelastic process is mainly of a peripheral nature (pp interaction) then elastic scattering will possess a Regge behavior. However, if nonperipheral processes (π-p interaction) play a significant role then such a behavior is absent. A mixed model is considered in which the scattering amplitude contains a Regge term as well as an ordinary diffraction term. Estimations of the relative yields of these terms based on experimental data on inelastic interactions qualitatively agree with the observed elastic scattering. Some consequences of such a model are discussed. (auth)

6047 ELASTIC SCATTERING OF PROTONS ON PROTONS AT SMALL ANGLES AND AT 6 to 10 Bev. L. F. Kirillova, V. A. Nikitin, A. A. Nomofilov, V. A. Sviridov, L. N. Strunov, and M. G. Shafranova (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1261-6(Oct. 1963). (In Russian)

Measurements on 22000 elastic scattering events were carried out with an accuracy of 4.5 to 7.5%. At 10 Bev the cross sections were measured at 12 points between center-of-mass angles 1.5 and 7.5°. The corresponding interval of the transmitted 4-momentum square was $0.0038 \text{ Bev } 2/c^2 < t < 0.081 \text{ Bev } 2/c^2$. Similar measurements were made for 6 Bev at angles from 1.5 to 9°. A detailed study was made of the angular range in which Coulomb scattering plays an important part, and there is a correlation between Coulomb and nuclear scattering amplitudes. Differential cross sections of p-p scattering at 6 to 10 Bev, after subtracting purely Coulomb cross sections, were determined, and the cross section excess was observed for both energies at $t < 0.015 \text{ Bev } 2/c^2$. Two interpretations are given for the above peculiarity. (R.V.J.)

6048 SCATTERING OF LIGHT ON LIGHT. V. M. Arutyunyan, F. R. Arutyunyan, K. A. Ispiryan, and V. A. Tumanyan (Inst. of Physics, Erivan). Zh. Eksperim. i Teor. Fiz., 45: 1270-2(Oct. 1963). (In Russian)

Detection and measurements of light-light scattering were accomplished by using laser photons and bremsstrahlung quanta generated by high energy electron beams. In the scattering of 33 to 40 Bev γ quanta generated by

electrons in the laser beam, 10 to 15 photons per hour were recorded with 500-Mev energies. (R.V.J.)

6049 SCATTERING THEORY IN THE IMPULSE APPROXIMATION. G. K. Ivanov and Yu. S. Sayasov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1456-66(Nov. 1963). (In Russian)

A new formulation of the impulse approximation method is presented that differs from the original method by greater simplicity. Thus the scattering cross section of a particle incident on a complex system is represented by a certain mean value over the initial state; under some additional assumptions the cross section for transition of a system to a prescribed final state can be described by a formula that is an extension of the Fermi pseudopotential method to the case of arbitrary pair interactions. The generalized method is employed for calculating resonance scattering of neutrons by chemically bound atoms in the case of sufficiently broad resonances. (auth)

6050 EFFECT OF ANNIHILATION ON PERIPHERAL NUCLEON-ANTINUCLEON INTERACTIONS. D. S. Chernavskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1558-65(Nov. 1963). (In Russian)

The question of why the cross sections for peripheral interactions between nucleons or between a nucleon and antinucleon at an energy ~2 Bev differ by several times whereas according to the single-meson approximation they should be the same, is considered. A possible cause is that in the case of nucleon–antinucleon interaction intense annihilation occurs that suppresses all other processes in virtue of the unitarity condition. The effect of the unitarity condition is estimated by means of the scattering matrix and optical model. This estimation shows that in the case of nucleon–nucleon interaction the unitarity condition has a small effect, whereas it is large in the case of nucleon–antinucleon interaction and may explain the disagreement. (auth)

6051 REGGE POLES IN THE PHOTOPRODUCTION AMPLITUDE. A. V. Berkov, E. D. Zhizhin, V. D. Mur, and Yu. P. Nikitin. Zh. Eksperim. i Teor. Fiz., 45: 1585-94(Nov. 1963). (In Russian)

The spin structure of the amplitude for photoproduction of π-mesons on nucleons is examined on the basis of the concept of moving scattering amplitude poles as a function of the orbital momentum. The Regge poles are classified with respect to various quantum numbers. Polarization of recoil nucleons in photoproduction of π-mesons on a polarized target and the polarization of γ quanta produced in slowing down of fast π-mesons due to interaction with nucleons are calculated. It is shown that the contributions from different poles yield qualitatively different results for the polarization. The amplitude for photoproduction of π-mesons on nucleons at an angle of 0° is considered. (auth)

6052 PHYSICAL REGION OF A FIVE-TAIL IN TERMS OF FIVE INVARIANTS. V. P. Pavlov (Steklov Inst. of Mathematics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1606-11(Nov. 1963). (In Russian)

An explicit form of the boundary of the physical region of a five-tail in space of Lorentz invariant variables, on which its amplitude depends, is derived. The structure and mutual arrangement of the physical regions of various channels for an arbitrary inelastic process is discussed. (auth)

6053 ELECTRODYNAMIC INTERACTION OF A GROUP OF CHARGES DURING SCATTERING OF RADIATION. V. V. Yankov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1634-7(Nov. 1963). (In Russian)

Distribution of light pressure over different elements of a scattering system of free charges consisting of two electrons is investigated. It is shown that dissipative radiation pressure due to electron interaction is completely concentrated on the back (with respect to the direction of propagation of the incident wave) particle. If the distance between the charges is not too much greater than the wave length, then the indicated pressure is always positive, that is, it tends to make the back electron approach the front one. Short range quasi-stationary radiative forces that predominate at short distances lead to mutual repulsion of a pair of close electrons in the case of transverse polarization of the scattered wave and to mutual attraction in the case of longitudinal polarization. (auth)

6054 ANALYTICAL PROPERTIES OF THE AMPLITUDE IN THE QUASIPOTENTIAL SCATTERING PROBLEM. O. I. Zavyalov, M. K. Polivanov, and S. S. Khoruzhii (Inst. of Mathematics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1654-9(Nov. 1963). (In Russian)

It is shown that the second Born term for the scattering amplitude in the quasi-potential method recently proposed does not satisfy the Mandelstam representation if the mean particle radius is independent of energy. (auth)

6055 NOTE ON THE PRODUCTION OF AN ELECTRON-POSITRON PAIR BY A γ-QUANTUM, TAKING INTO ACCOUNT THE SPIN EFFECTS AND THE FINITE DIMENSIONS OF THE NUCLEUS. B. K. Kerimov and F. S. Sadykhov. p.400-4 of "Elektronika Uskoriteli." Tomsk, USSR, Tomsk University, 1961.

In the Born approximation an expression was found for the differential cross section of the production process of longitudinally polarized electron-positron pairs by circularly polarized γ quanta, taking into account the finite dimensions of the nucleus. The cross section is presented in the form $d\sigma = d\sigma_0 + d\sigma_1$, wherein $d\sigma_0$ is the pair production cross section on a point nucleus, taking into account the longitudinal spin states of a pair and the impinging γ quantum, $d\sigma_1$ is the portion of the cross section taking into account the effect of the root-mean-square radius of the nuclear electric charge distribution on the angular and longitudinal spin correlations between electron, positron, and γ quantum. (Ref. Zh. Fiz. No. 1, 1963)

6056 NUCLEAR RADIATION. Otto Henry Zinke. p.63-70 of "Proceedings of Nuclear Energy Conference." [Russellville, Arkansas, Arkansas Polytechnic College, 1963].

The common types of radiations encountered in the laboratory, namely those usually emitted by artificially produced radioactive isotopes and naturally occurring radioactive isotopes, are discussed. Radiations produced in fission processes whether controlled (such as in a nuclear reactor) or uncontrolled (such as in the explosion of a reactor, device, or bomb) are also included. Brief discussions are given on alpha and beta particles, gamma rays, and neutrinos. (P.C.H.)

Field Theory and Quantum Mechanics

6057 (AD-400614) ANGULAR MOMENTUM STATES. Nick Karayianis and Clyde A. Morrison (Harry Diamond Labs., Washington, D. C.). Mar. 8, 1963. 40p.

Theoretical techniques are incorporated into a unified but concise treatment of crystal field theory. Emphasis is placed on angular momentum states and the so-called

Clebsch-Gordan and Racah coefficients, which arise in the handling of such states. In order to illustrate the use of the formalism introduced in connection with the angular momentum states, a simple problem in quantum mechanics is solved in detail. The problem brings out some features of atomic systems such as the Zeeman effect and spin-orbit coupling, and illustrates the use of first- and second-order degenerate perturbation theory. (auth)

6058 (WAPD-TM-391) AN ALTERNATING DIRECTION METHOD FOR OPERATORS WITH AN APPLICATION TO THE TRANSPORT EQUATION. R. B. Kellogg (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1963. Contract AT-11-1-GEN-14. 44p.

The Peaceman-Rachford iterative method is studied for the solution of operator equations on a Hilbert space. The method is applied to the one-group inhomogeneous transport equation in rectangular and cylindrical geometry. (auth)

6059 ON THE INVERSION OF EIGENVALUE PROBLEMS. Egil A. Hylleraas (Univ. of Wisconsin, Madison and Univ. of Florida, Gainesville). Ann. Phys. (N. Y.), 25: 309-24(Dec. 1963).

Attention is drawn to a previous paper on the inverse scattering problem in quantum mechanics. Comparisons are made to more recent papers, and some generalizations are added. (R.E.U.)

6060 THE CONTINUATION IN TOTAL ANGULAR MOMENTUM OF PARTIAL-WAVE SCATTERING AMPLITUDES FOR PARTICLES WITH SPIN. Francesco Calogero (Princeton Univ., N. J.), John M. Charap, and Euan J. Squires. Ann. Phys. (N. Y.), 25: 325-39(Dec. 1963).

An assumed one-dimensional dispersion relation is used to define a continuation in total angular momentum of the helicity scattering amplitude for particles with arbitrary spin. The result, which is a generalization of the Froissart-Gribov formula for zero spin, agrees with that discussed previously for potential models. It is shown that cross-channel unitarity imposed certain restrictions on the weight functions. The existence of certain kinematic zeros of the amplitude, corresponding to the decoupling of "sense" and "nonsense" channels, is proved in general, and finally it is shown that the presence of the "nonsense-nonsense" amplitudes does not affect the large z behavior, which is still dominated by Regge poles. (auth)

6061 REGGE BEHAVIOR OF SCATTERING AMPLITUDE FOR A HIGHLY SINGULAR POTENTIAL. Yuan-pen Tai. Chung Kuo K'o Hsueh, 12: 1395-8(1963).

Regge behavior of the scattering amplitude for a highly singular potential was considered. The following properties of potential V were assumed: $V(z) \sim z^{-n}$, for $z \sim 0$, $n > 2$; $V(z)$ is analytic in Re $z > 0$; and $z^2V \to 0$, for $z \to \alpha$ in Re $z > 0$. The radial wave function satisfies the following equation: $\ddot{\psi} = (V + \lambda^2 - \frac{1}{4}/x^2 - K^2)\psi$, where $\lambda = l + \frac{1}{2}$. For a potential which is attractive near the origin, $\ddot{\psi} = x^{-n}\psi$, $x \sim 0$. By comparing this equation with $\psi = -a^{-n}\psi$ and applying the comparison theorem, it was determined that every solution of first equation has infinitely many zeros near the origin. In this case no reasonable boundary condition can be formulated. Thus only the potential which is repulsive near the origin is considered. The results obtained can be applied to a potential with repulsive core and Yukawa tail. It can be shown that $\nu l \leq C(\log |\lambda|/|\lambda|)$ and $s(\lambda,k) - 1 \leq C(\log |\lambda|/|\lambda|)$, as $|\lambda| \to \alpha$, Re$\lambda > 0$. The Regge asymptotic behavior of the scattering amplitude thus follows the last equation and the mesomorphic property of $s(\lambda,k)$. (OTS)

6062 CONFORMAL THEORY OF C_6 OF PARTICLES HAVING MAXIMAL SPIN ½ AND 1. Andrei Popovici, Anatole Hristev, and Julien Popovici (Faculté des Sciences Mathématiques et Mécaniques, Bucharest). Compt. Rend., 257: 3120-2(Nov. 18, 1963). (In French)

Given C_6, V_6, H_6, and E_6 of signature +++−+−, these matrices unite certain Dirac tensors and de Broglie tensors. Divergences, the "fusion" theorem, non-conservation of parity in weak interactions, and a particular transformation (m = −m) result automatically in covariance on C_6. (tr-auth)

6063 QUATERNIONIC QUANTUM MECHANICS AND RESTRICTED RELATIVITY. [PART] I. Gérard Emch (Université, Geneva). Helv. Phys. Acta, 36: 739-69(1963). (In German)

The possibility of a quantum mechanical description in which the observables are realized as self-adjoint operators in quaternionic Hilbert spaces was investigated from the point of view of relativistic invariance. The problem was first formulated in the natural language of quantum mechanics, i.e., the one of proposition systems. This was followed by the theory of projective group representation and their reduction to unitary group representations in quaternionic Hilbert spaces. The general theory was then applied to the group of special relativity. (auth)

6064 QUATERNIONIC QUANTUM MECHANICS AND RESTRICTED RELATIVITY. [PART] II. Gérard Emch (Université, Geneva). Helv. Phys. Acta, 36: 770-88(1963). (In German)

The implications of group theory for the foundations of quaternionic quantum mechanics are discussed. It is proved that even in this case a relativistic description is possible. It is shown that the elementary systems for the Poincaré group, as they appear in this realization, are in one-to-one correspondence with those of the usual complex quantum mechanics. The occurrence of charge conjugation related to space reflexion is discussed and some consequences on a TCP-relativistic theory are explored. The framework of a general relativistic quaternionic quantum mechanics is developed and the particular ties that exist between this theory and its complex analog are emphasized. The possible adequacy of a mixed complex-quaternionic description for isospin is discussed. (auth)

6065 AMPLIFICATION OF WAVES DUE TO QUANTA WITH NEGATIVE ENERGY. Toshimitsu Musha (Electrical Communication Lab., Tokyo). J. Appl. Phys., 35: 137-41 (Jan. 1964).

Wave energy moving faster than the phase velocity of the wave in the medium becomes negative. Such a wave field can equally well be treated as an ensemble of quanta with negative energy. Amplification of waves by mode coupling is represented by pair creation of a negative quantum and a positive quantum. Interaction of an electron stream with a dissipative medium creates the negative quanta. (auth)

6066 THE MASTER EQUATION WITH SPECIAL TRANSITION PROBABILITIES. E. Verboven (Studiecentrum voor Kernenergie, Mol, Belg.). J. Math. Phys. (N. Y.), 4: 266-70(Feb. 1963).

The Van Hove master equation to general order is solved, making a special ansatz for the function $W_{11'}(kk')$. Approximate solutions are found for strong and weak coupling. For $\lambda = 1$, a comparison is given with the exact numerical solution. (auth)

6067 INVARIANCE OF QUANTUM FIELD THEORY UNDER POINT TRANSFORMATIONS OF THE FIELD VARIABLES. I. BOSON FIELDS. C. A. Orzalesi (Università, Pavia, Italy and I.N.F.N.-Gruppo, Pavia, Italy). Nucl. Phys., 48: 443-50(Oct. 1963).

The point transformations of the field variables u_i(i =

1, 2, . . ., n) of a boson field are investigated. First of all, it is proved that the point transformations are also canonical transformations. Then making use of the Schwinger action principle, it is proved that they leave invariant the Euler-Lagrange equations, the energy-momentum four-vector P_ν and the commutation rules $[P_\nu, u_i]$. The invariance of the energy-momentum tensor $T_{\mu\nu}$ is also proved. (auth)

6068 INTERACTION OF QUANTIZED AND UNQUANTIZED SYSTEMS. Asher Peres (Israel Inst. of Tech., Haifa). Nucl. Phys., 48: 622-4(Nov. 1963).

It is shown that interactions between quantized and unquantized systems do not lead to any dynamical inconsistencies. However, if the equations of motion of the classical system depend on the state of the quantized system, then the latter no longer satisfies a linear dynamical equation. This fact may have implications in the quantization of the gravitational field and in the quantum theory of measurement. (auth)

6069 THEORY OF THE INSULATING STATE. Walter Kohn (Univ. of California, La Jolla). Phys. Rev., 133: A171-81(Jan. 6, 1964).

A new and more comprehensive characterization of the insulating state of matter is developed. This characterization includes the conventional insulators with energy gap as well as systems discussed by Mott that, in band theory, would be metals. The essential property is this: Every low-lying wave function Φ of an insulating ring breaks up into a sum of functions, $\Phi = \Sigma_{-\infty}^{\infty} \Phi_M$, that are localized in disconnected regions of the many-particle configuration space and have essentially vanishing overlap. This property is the analog of localization for a single particle and leads directly to the electrical properties characteristic of insulators. A soluble model exhibiting a transition between an insulating and a conducting state is discussed. (auth)

6070 BROKEN SYMMETRIES AND ZERO-MASS BOSONS. M. Baker (Univ. of Washington, Seattle), K. Johnson, and B. W. Lee. Phys. Rev., 133: B209-13(Jan. 13, 1964).

It is argued by reference to the example of quantum electrodynamics that zero-mass bosons are not necessarily present in a theory with broken symmetries. (auth)

6071 GENERAL RELATIVITY IN TERMS OF A BACKGROUND SPACE. F. H. J. Cornish (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 276: 413-17 (Dec. 3, 1963).

The path of a test particle, the light rays, and the gravitational red shift predicted by general relativity for the case of the Schwarzschild metric may all be interpreted in terms of Euclidean space. By introducing the concept of a background space it is shown that this interpretation may be extended for the case of any finite static gravitating system. It is pointed out that the interpretation is applicable to any theory of gravitation in which the path of a test particle and the light rays are geodesics of the space-time metric. (auth)

6072 CONCERNING THE SYMMETRY PROPERTIES OF THE REDUCED DENSITY MATRIX AND THE NATURAL SPIN ORBITALS AND SPIN GEMINALS (THE NATURAL ONE- AND TWO-ELECTRON FUNCTIONS). Werner Kutzelnigg (Université, Paris). Z. Naturforsch., 18a: 1058-64(Oct. 1963). (In German)

The density operator (density matrix) of a quantum mechenical system can be decomposed into operators which transform as irreducible representations of the symmetry group in coordinate and spin space. Each of these components has a physical meaning connected with the expectation values of certain operators. The reduced density matrices can be decomposed in a completely analogous way. The symmetry properties of the total wave function give rise to degeneracies of the eigenvalues of the reduced density matrices. These degeneracies can be removed by requiring that the natural spin orbitals (NSO, defined as the eigenfunctions of the first-order density matrix), as well as the natural spin geminals (NSG, the eigenfunctions of the second-order density matrix) and their spinless counterparts transform as irreducible representations of the symmetry group and are eigenfunctions of S^2 and S_z. In many cases this requirement is compatible with the original definition of the NSO, the NSG, etc., e.g., when there is no spatial degeneracy of the total wave function and when the Z-component of the total spin vanishes. When these conditions are not fulfilled an alternative definition of the NSO and the NSG is proposed. (auth)

6073 RENORMALIZATION CONSTANTS AND BOUND STATES IN A NONRELATIVISTIC MODEL IN FIELD THEORY. M. A. Braun (Leningrad State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 936-47(Oct. 1963). (In Russian)

A nonrelativistic model is investigated that is a certain generalization of quantum mechanics of two particles interacting with a potential. A new point interaction of the particles is introduced, which involves their transition into another particle that has the same quantum numbers as the bound state of the first particles. In the theory thus developed, the mass of the introduced particle and its interaction constant are arbitrary. In the particular case when the mass of the introduced particle is chosen so that its mass exactly equals that of the bound state of the first particles, the theory is identical with ordinary quantum mechanics. The renormalization constants in this case vanish. (auth)

6074 A NEW METHOD FOR INVESTIGATION OF FEYNMAN DIAGRAM SINGULARITIES. A. P. Rudik and Yu. A. Simonov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1016-29(Oct. 1963). (In Russian)

The essence of the method is that the diagrams are divided into separate parts whose singularities are known. An equation is derived that expresses the singularity of a diagram as a whole in terms of singularities of the constituents. For a number of diagrams the singularities were determined by the new method as well as by the Landau method. (auth)

6075 SPACE-TIME STRUCTURE OF THE RELATIVISTIC SCATTERING MATRIX. Yu. A. Golfand (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1067-80(Oct. 1963). (In Russian)

A general, relativistically invariant method for constructing the S-matrix in field theory is proposed in which T-products are not employed. Two different representations of the S-matrix are set up on the basis of the method. It is shown that the problem of constructing the S-matrix can be reduced to solution of a certain set of integral equations. Equivalence between the proposed method and the usual formulation of field theory is proven. Unitarity of the S-matrix is proven explicitly. (auth)

6076 AMPLITUDE SINGULARITIES AT $l = -1$ IN THE BETHE–SALPETER EQUATIONS. V. G. Vaks and A. I. Larkin. Zh. Eksperim. i Teor. Fiz., 45: 1087-1101 (Oct. 1963). (In Russian)

Singularities of the scattering amplitude for $l = -1$ are related to the singularity of the irreducible four-pole network in the Bethe–Salpeter equation. Under some reasonable assumptions concerning the properties of the network, it is shown that the contribution to the asymptotic amplitude due to condensation of the poles is small, providing the poles are close to $l = -1$. (auth)

6077 NONRELATIVISTIC REGGE POLE TRAJECTORIES. [PART] I. V. A. Kolkunov. Zh. Eksperim. i Teor. Fiz., 45: 1123-32(Oct. 1963). (In Russian)

The motion of Regge poles for potentials of the $r^{2\epsilon-2} \exp[-(\mu r)^{2\tau}]$ type is studied for $\epsilon > 0$ and $\tau > 0$ as a function of the coupling constant g and energy $E = k^2/2m$ on basis of the exact solution of the Schroedinger equation. (auth)

6078 THEORY OF MULTIPLE SCATTERING. Yu. N. Gnedin and A. Z. Dolginov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 45: 1136-49 (Oct. 1963). (In Russian)

A theory for multiple scattering of particles traversing a body of finite dimensions is proposed. Quantum mechanical equations for multiple scattering are employed. It is assumed that the force centers are distributed randomly and $N_0 a^2 \lambda \ll$ where λ is the wave length of the incident particle, a is the scattering amplitude and N_0 the concentration of spin centers. An explicit expression for the intensity of scattered particles in and outside the body is obtained. (auth)

6079 ADIABATIC APPROXIMATION FOR DEGENERATE OR ALMOST DEGENERATE STATES. G. F. Drukarev (Leningrad State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1484-92(Nov. 1963). (In Russian)

The behavior of a system under the action of a time-dependent perturbation is considered in the adiabatic approximation, degeneracy being assumed in the absence of the perturbation. The state of the system is characterized by the density matrix in space of eigenfunctions belonging to a given degenerate level. A unitary operator is set up that relates the density matrix before the perturbation is turned on to that after the perturbation is turned off. The case when there is no exact degeneracy in the absence of a perturbation but rather a set of closely spaced levels (almost degenerate states) is also considered. As an illustration of application of the theory, the behavior of spin 1 and ½ particles in a variable magnetic field is examined. (auth)

6080 STRUCTURE OF SINGULARITIES AND THEIR MOTION IN NONLINEAR ELECTRODYNAMICS. S. V. Peletminskii and A. A. Yatsenko. Zh. Eksperim. i Teor. Fiz., 45: 1625-33(Nov. 1963). (In Russian)

The structure of singularities whose motion is almost uniform is studied in nonlinear electrodynamics. The equation of motion of singularities is obtained for this case and it is shown that uniform and rectilinear motion is stable with respect to perturbations for any choice of the electromagnetic field lagrangian. Generally speaking, mass renormalization violates stability of the motion. (auth)

Geophysics

6081 (ARF-A204-3) INVESTIGATION OF TECHNIQUES FOR THE REMOVAL OF ELECTRONS IN THE UPPER ATMOSPHERE. Final Report, December 1, 1961 through December 31, 1962. Robert D. Sears (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Contract AF19(628)-316. 23p. (AFCRL-63-52; AD-299588)

Electron equilibrium energy in the D and lower E region of the ionosphere is calculated from a relationship between electron energy loss and attachment characteristic times. It is shown that solar photodetachment of electrons from O_2^- ions, which is the major short-term ionization source between 50 and 90 km, is a source of energetic electrons of 2.9-ev mean energy. Thus competition between energy loss by rotational excitation of molecules and dissociative attachment to oxygen will exist as the most probable processes for 3-ev electrons. Approximate conditions are defined that allow calculation of maximum mean electron energy at equilibrium for the undisturbed or slightly disturbed daytime ionosphere. Comparison of these maximum values with a measured electron energy of 0.15 ev at 40 km shows agreement within a factor of 2, which may be accounted for by the disturbed condition of the ionosphere during the measurement. The range of maximum permissible electron energies lie between 1.2 times ambient at 30 km to 42 times ambient (0.74 ev) at 90 km. A method is outlined whereby one parameter among the set (equilibrium electron energy, energy loss characteristic time, or electron removal characteristic time) can be determined if the other two can be found experimentally and if the mean source energy of the electrons is known. Thus radio measurement techniques such as the Luxemburg effect or rocket probes can be used to relate temperature measurements and electron density measurements through a reaction model based upon estimation of characteristic times of competing processes. (auth)

6082 (RM-3671-PR) AIR CONDUCTIVITY PRODUCED BY NUCLEAR EXPLOSIONS. W. J. Karzas and R. Latter (RAND Corp., Santa Monica, Calif.). May 1963. Contract AF49(638)-700. 18p.

Theoretical prediction of the nature of electromagnetic signals from nuclear explosions and their effects on military systems requires knowledge of the explosion-induced air conductivity. In the past, there was substantial uncertainty about how to calculate this conductivity, arising from the uncertainty in the spectrum of secondary electrons as they slow down. This spectrum is estimated, and the electronic conductivity per electron is shown to be equal to that for a mean electron energy corresponding to thermal and electrical equilibrium. For sea-level nuclear explosions, this mean energy is determined by the equilibrium electric field of about 1 esu and is about 0.16 ev. (auth)

6083 THE SOLAR WIND VELOCITY AND ITS CORRELATION WITH COSMIC-RAY VARIATIONS AND WITH SOLAR AND GEOMAGNETIC ACTIVITY. Conway W. Snyder (Jet Propulsion Lab., Pasadena, Calif.), Marcia Neugebauer, and U. R. Rao. J. Geophys. Res., 68: 6361-70 (Dec. 15, 1963).

Mariner 2 obtained data on the interplanetary plasma during the period August 29, 1962, through January 3, 1963. The daily average plasma velocity is presented and compared with data on cosmic-ray diurnal variations and with indices of solar and geomagnetic activity for this period. The only strong correlation found is that between plasma velocity and the geomagnetic index K_p. The plasma velocity showed a very strong 27-day recurrence tendency and a close association with M-region geomagnetic storms, indicating that solar M regions are emitters of high-velocity plasma. No dependence of plasma velocity on solar distance between 1.0 and 0.7 AU could be detected. (auth)

6084 THE DISTANT GEOMAGNETIC FIELD. 5. LONG-PERIOD OSCILLATIONS. C P. Sonett (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 68: 6371-6(Dec. 15, 1963).

Long-period magnetic oscillations (≥100 seconds) seen on the Pioneer 1 flight are discussed. The indication is that these oscillations are comparable in scale to the magneto-

sphere and are primarily radial, that is, are contained in geomagnetic meridian planes. The energy densities agree with the fluctuation level in the free-stream solar wind and suggest the excitation mechanism discussed by Dessler based on a fluctuating solar wind pressure. (auth)

6085 THE S_q VARIATION AT GEOMAGNETICALLY CONJUGATE AREAS. E. M. Wescott, R. N. DeWitt, and Syun-Ichi Akasofu (Univ. of Alaska, College). J. Geophys. Res., 68: 6377-82(Dec. 15, 1963).

The S_q variation at geomagnetically conjugate areas is examined by use of the San Juan-Trelew pair. It is shown that there is no particular similarity of the S_q variation at the two stations and that the northern and southern foci of the S_q current system are not geomagnetically conjugated. Three important causes of the asymmetric S_q variations are discussed. The asymmetric part of the solenoidal component of the dynamo current could be an immediate cause. The coupling of the northern and southern ionospheres by the geomagnetic field lines tends to exaggerate the effect of the difference in the induced polarization field, rather than to reduce it; further, because of the global scale of the system the inductance of the circuit may play an important role in skewing the S_q variations. Such a dissimilarity of the S_q variation at the conjugate points is in contrast to a striking similarity of polar magnetic storms at the conjugate points in the northern and southern auroral zones. The dynamo theory of polar magnetic storms is criticized on this basis. (auth)

6086 THE NONCYCLIC VARIATION DURING QUIET DAYS. Albert T. Price (Rand Corp., Santa Monica, Calif. and Exeter Univ., Eng.). J. Geophys. Res., 68: 6383-9 (Dec. 15, 1963).

New methods of studying S_q during the IGY revealed a clear pattern of the noncyclic variation field that was not discernible from earlier studies. The field is mainly zonal about the geomagnetic axis, though there are significant departures from axial symmetry. The zonal part corresponds closely to a uniform field plus a dipole field along the geomagnetic axis. The relative values of these two parts accord well with the assumption that the internal part arises from currents induced in the earth by D_{st} variations. The relation between the noncyclic variations and hourly values of equatorial D_{st} is discussed. (auth)

6087 SELECTION OF A MODEL OF THE EARTH'S MAGNETIC FIELD. Robert S. Leonard (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 68: 6437-40 (Dec. 15, 1963).

Several methods were proposed for calculating the magnitude and direction of the geomagnetic field at locations above the earth's surface. During the 1962 Johnston Island explosions, observations were made of the man-made aurora caused by β particles guided into the southern conjugate region by the geomagnetic field. The measured location of the initial disturbance was compared with the location calculated by several different models of the geomagnetic field; the average differences between the observed and calculated points are tabulated. The Jensen and Cain coefficient set is found to give the smallest average difference in the region studied. (auth)

6088 INVESTIGATION OF THE MAGNETIC FIELD IN SPACE. Sh. Sh. Dolginov and N. V. Pushkov. Kosmich. Issled., 1: No. 1, 55-97(1963).

Experimental data on the magnetic fields of the earth, moon, and interplanetary space, obtained by Soviet and U. S. rockets and missiles, were surveyed, and the results of measurements were near the earth, in the outer radiation belt, and at the boundary of the geomagnetic field were compared. It was found that the energy necessary to create and maintain the outer zone is supplied by the sun, but the mechanism whereby the solar plasma energy is transferred to the magnetosphere is still not clearly understood. It was not possible to determine with finality where or whether the classic current system associated with the main phase of magnetic storms actually exists. It was found that: at distances exceeding 8 R_e (radius of the earth) the measured values of the field on the day and night sides of the earth exceed those theoretically computed, the direction of the field at distances up to 12 R_e differs from 30 to 60° from the direction of the dipole field, considerable field fluctuations are noted in the region from 10 to 15 R_e, no notable difference exists in the characteristics of the terrestrial field on the day and night sides, a transition zone probably exists in the 10 to 15 R_e region between solar plasma and the geomagnetic field, information is lacking on comparative conditions in the 12 to 15 R_e region, and it is possible for a magnetic trail to exist on the night side. (OTS)

6089 CALCULATIONS AND LOCAL MODELS OF THE NEAR GEOMAGNETIC FIELD. E. Golton (D.S.I.R. Radio Research Station, Slough, Eng.). Planetary Space Sci., 11: 1263-72(Nov. 1963).

The value of the geomagnetic field at epoch 1955 was calculated using a sixth-order spherical harmonic model. The results are presented in the form of maps showing, for a height of 2,000 km, the deviations from the ground-level values of dip, declination, and total field. The coefficients of the harmonic model were extrapolated to 1960. The accuracies of various simpler models of the field are considered, particularly for use in the case when field values are required in a limited region only. It is concluded that a second-order spherical harmonic model with suitably adjusted coefficients is a good choice for such local use. (auth)

6090 THEORIES OF THE GEOMAGNETIC STORM MAIN PHASE. J. H. Piddington (CSIRO, Sydney). Planetary Space Sci., 11: 1277-88(Nov. 1963).

The main phase of a geomagnetic storm may be explained in terms of ring currents caused by drifts of trapped ions; D_{st} requires a symmetrical ring and DS an unsymmetrical ring. Alternatively both components may be caused by a geomagnetic tail; its field lines may link with the earth and be open or closed. Other field lines may be created from the interplanetary field. A comparison of these theories is first made on a theoretical basis. Some objections to the unsymmetrical ring current are raised; the symmetrical ring current and tail are both likely to occur, the latter being maintained by gas that becomes attached to the field lines. The theories are compared with sea-level geomagnetic storm data, both averaged and for individual storms and sub-storms. It is concluded that the main phase D_{st} component is caused by the combined effects of a ring current and a tail, in varying proportions. DS is caused partly by magnetospheric motions that result from twist deformations of the field lines and partly from a tail into which plasma remains frozen. Weak, moderate and great storms all result from solar winds of the same average intensity and duration. The different main-phase intensities result from differing degrees of frictional interaction, the difference perhaps depending on the interplanetary magnetic field strength and direction. Magnetometers and ion counters in spacecraft and ionospheric observations tend to confirm the conclusions. The diurnal variation in latitude of geomagnetically trapped electrons is explained in terms of a geomagnetic tail as are other observed diurnal effects. (auth)

6091 JOULE HEATING AT THE MAGNETIC EQUATOR. S. Kato (CSIRO, Camden, New South Wales). Planetary Space Sci., 11: 1297-1302(Nov. 1963).

Joule heating of electrons and ions at the magnetic equator, where intense electric current flows, is discussed. It is shown that the power generated is between 10^{-8} and 10^{-7} erg cm^{-3} sec^{-1} and that the electron temperature is raised above the neutral particle temperature by several tens of °K. This temperature increase could cause the electron density along the current lines to fluctuate; this may be the explanation of equatorial sporadic E. The heated electrons are very nearly in thermodynamic equilibrium, and have their own temperature. Various dissipative processes are discussed. (auth)

6092 IONOSPHERIC ELECTRON CONTENT AND DISTRIBUTION DETERMINED FROM SATELLITE OBSERVATIONS. Owen K. Garriott (Stanford Univ., Calif.). p.371-86 of "Space Research." New York, Interscience Publishers, 1960.

Observations of the polarization rotation of the signals from Sputnik III provided values of the integrated electron density up to the satellite height. In the eight month period analyzed, the high passages yielded measurements of the total ionospheric electron content and its diurnal variation. As the height of the low passages increased from less than 300 to over 900 km at the observing latitude, an estimate of the average electron density profile was obtained. This profile shows a reduction in electron density to 50% of the maximum values at a level of 135 km above the height of maximum density and a concentration equal to 20% of the maximum at a level of 450 km above the height of the maximum density. Severe distortions of the quiet-day profile are implied by measurements of the total electron content on days of high magnetic activity. (auth)

6093 IONOSPHERIC POSITIVE IONS. C. Y. Johnson and J. C. Holmes (Naval Research Lab., Washington, D. C.). p.417-19 of "Space Research." New York, Interscience Publishers, 1960.

The relative abundance of ions of mass 32, 30, and 16 was measured between 90 and 250 km in the Arctic ionosphere. The significance of mass 28 and mass 18 ions is discussed. The mechanics of this measurement are briefly examined. (auth)

6094 ENHANCED IONIZATION IN THE POLAR IONOSPHERE AND SOLAR CORPUSCULAR RADIATION. T. Obayashi and Y. Hakura (Radio Research Labs., Tokyo). p.665-94 of "Space Research." New York, Interscience Publishers, 1960.

Greatly enhanced ionization in the lower ionosphere occurs in the polar region several hours after a large solar flare, accompanied by major radio outbursts of type IV. Radio blackouts develop inside the entire polar cap without any marked geomagnetic activity. They are caused by the invasion of particles of energy 10 to 100 Mev generated in an agitated solar coronal plasma bearing magnetic fields. With the onset of a magnetic storm the blackout region spreads from the polar cap to the auroral zone. An improved version of the Störmer theory is applied to these and the phenomena, including the increase of cosmic-ray intensity during the main phase of a magnetic storm, are explained by a decrease of geomagnetic cut-off for incoming particles by the contraction of the geomagnetic cavity. (auth)

6095 DIRECT MEASUREMENT OF PROTONS AND ELECTRONS IN VISIBLE AURORAE. Carl E. McIlwain (Iowa State Univ., Iowa City). p.715-20 of "Space Research." New York, Interscience Publishers, 1960.

The nature of the particles that produce visible auroras was investigated with the aid of rocket borne scintillation detectors. Magnetic fields were used to separate the proton and electron components of the particle flux. A quiescent auroral glow of about intensity I was investigated. A total energy flux of about 3 ergs/sec cm^2 sr and a flux of protons with greater than 70 kev energy above the atmosphere of 2.7×10^5 protons/sec cm^2 sr was measured. An H_β spectral line intensity of about 6×10^7 quanta/sec cm^2 was measured. The dependence of the energy flux with variations in the associated magnetic field indicated that at least 60 per cent of the energy flux was due to electrons. An active aurora of about intensity III was also investigated. A total energy flux of up to 100 ergs/sec cm^2 was observed of which at least 90 per cent was due to electrons. The flux of protons with energies greater than 100 kev above the atmosphere was less than 10^4/sec cm^2 sr. No H_β spectral line was detectable during this measurement. In both investigations the flux of electrons with energies above one Mev was less than 0.2 electrons/sec cm^2 sr. (auth)

6096 DIRECT MEASUREMENTS OF PARTICLE FLUXES IN AND NEAR AURORAS. L. R. Davis, O. E. Berg, and L. H. Meredith (Naval Research Lab., Washington, D. C.). p.721-35 of "Space Research." New York, Interscience Publishers, 1960.

Direct measurements of the particle fluxes, types, and energies in and near visible auroras were obtained. The results show that in both the rays and diffuse forms that were penetrated, the auroral luminosity was primarily due to electrons incident on the upper atmosphere. The electron intensity was found to be roughly isotropic over the upper hemisphere. No electrons were detected outside auroras. Protons, having energies up to a few hundred kev, were found both inside and outside auroras. Details of the measurements and the experimental results are presented. (auth)

6097 GEOPHYSICAL EVIDENCE BEARING ON ORBITAL VARIATIONS OF SATELLITES AND ON THE RADIATION BELTS. J. Bartels (Max-Planck-Institut für Aeronomie, Göttingen, Ger. and Universität, Göttingen, Ger.). p.841-4 of "Space Research." New York, Interscience Publishers, 1960.

Observed orbital variations of satellites as well as the newly discovered radiation belts and their fluctuations, are related to known physical phenomena, that were observed for several decades. Auroral height measurements, which show an enormous increase in northern latitudes during intense magnetic storms; large lunar tidal effects in the ionosphere, which are possibly generated at several earth radii; and two types of 27-day periods—solar wave radiation and solar corpuscular radiation—are discussed. (auth)

6098 ENERGY SPECTRA AND ALTITUDE DEPENDENCE OF ELECTRONS TRAPPED IN THE EARTH'S MAGNETIC FIELD. M. Walt (Lockheed Missiles and Space Div., Palo Alto, Calif.), L. F. Chase, Jr., J. B. Cladis, W. L. Imhof, and D. J. Knecht. p.910-20 of "Space Research." New York, Interscience Publishers, 1960.

Measurements of the intensity and energy spectrum of electrons trapped in the geomagnetic field were made using a magnetic spectrometer carried by a rocket. The rocket reached an altitude of 1045 km. Energy spectra were obtained as a function of altitude over the energy interval from 30 kev to about 1 Mev. At all altitudes the number of electrons per unit energy interval decreases with increasing energy. The flux of electrons with energy greater than 1.5 Mev and protons with energy greater than 1 Mev was

found to be less than one-hundredth the flux of electrons between 30 kev and 1 Mev. A Schonstedt magnetometer was used to correlate the direction of the measurements with the direction and intensity of the geomagnetic field. (auth)

6099 GEOPHYSICAL EFFECTS OF THE TRAPPED PARTICLE LAYER. R. Jastrow (Goddard Space Flight Center, Washington, D. C.). p.1009-18 of "Space Research." New York, Interscience Publishers, 1960.

Analyses by Jacchia and others suggest that the upper atmosphere is heated appreciably by ultraviolet radiation and particle streams emitted by the sun during periods of solar surface activity. Satellite measurements have demonstrated that an appreciable part of the population of the trapped particle regions is supplied by injection from solar streams into the outer atmosphere during periods of unusual solar activity. The rate of energy transfer from the trapped particle population to the atmosphere was estimated, and is great enough to produce substantial temperature increases, of the order of 1000°, at altitudes of several hundred kilometers. Evidence was also obtained for a relation between the properties of the energetic particle population and the generation of auroral displays. (auth)

6100 THE EFFECT OF SOLAR WIND ON THE LUNAR ATMOSPHERE. J. R. Herring and A. L. Licht (Goddard Space Flight Center, Washington, D. C.). p.1132-45 of "Space Research." New York, Interscience Publishers, 1960.

The properties of the solar wind during sunspot minimum are discussed. The effect of the solar wind on the lunar atmosphere is analyzed. With certain assumptions, it is estimated that by collision of solar wind protons with the lunar surface, an atmosphere of cold neutral hydrogen is produced with a density of 10^5 cm^{-3} at the lunar surface. Based on these results an extended lunar ionosphere is deduced with a density of the order of 400 protons cm^{-3} in the vicinity of the moon. (auth)

Low Temperature Physics

6101 (AD-402708) RULES FOR THE OCCURRENCE OF SUPERCONDUCTIVITY AMONG THE ELEMENTS, ALLOYS, AND COMPOUNDS. Gerhart K. Gaule (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). [nd]. 43p.

The Matthias Rule (MR) predicting the occurrence of superconductivity among the elements is formulated as a set of five laws and is modified for alloys and compounds. Three supplementary laws pertaining to the influence of compound formation on T_c are given, and the theoretical basis for the established rules is outlined. Some notable deviations from the MR are discussed, and a rule for systems that contain transition metal (TM) atoms in the form of chains or prisms, such as TM borides, is proposed. (D.C.W.)

6102 (AD-423735) SUPERCONDUCTIVITY, 1961–1962: AN ANNOTATED BIBLIOGRAPHY, SUPPLEMENT I. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Apr. 1963. 94p. (SB-63-33)

References (196) to 1961–1962 literature on current theory, properties, and applications of superconductors are included. Both English and foreign language publications are represented. The entries are arranged alphabetically according to author, and author and subject indexes are provided. (D.C.W.)

6103 (AI-Trans-18) AN EMPIRICAL LAW CONCERNING TRANSITION TEMPERATURES OF SUPERCONDUCTING ELEMENTS OF THE PERIODICAL SYSTEM. W. Schaafs. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Naturwissenschaften, 50: 470-1 (1963). 4p.

An examination of the relation between the transition and boiling temperatures of the 24 superconducting elements reveals an ordering among the elements and yields a formula that indicates that all elements have a superconduction zone, but that currents can only flow if free electrons are present. (D.C.W.)

6104 CONCENTRATION DEPENDENCE OF THE TRANSITION TEMPERATURE IN DILUTE SUPERCONDUCTING ALLOYS. Lewis T. Claiborne (Texas Instruments Inc., Dallas). Phys. Chem. Solids, 24: 1363-7 (Nov. 1963).

A semi-empirical formalism was developed to account for the detailed dependence of the superconducting transition temperature of dilute alloys on solute concentration. A mismatch of solute and solvent ion sizes causes small strain fields in the regions surrounding the solute ions. The precise change in transition temperature, ΔT_c, for a particular solute concentration, N_s, is derived by averaging the strain over the entire sample and reducing the strain field by a factor $\exp\{\alpha - \xi r_{eff}^{-1}\}$, where α is a constant of order unity, ξ is the coherence distance, and r_{eff} is the total length of the strained region within ξ. The length, r_{eff}, is proportional to $N_s^{\frac{1}{3}}$. It was found that the strain is proportional to ΔR, the difference in ionic radii. Previously reported data on the effects produced by various solutes in tin, indium, and aluminum are explained in terms of this model. (auth)

6105 THE SPECIFIC HEAT JUMP IN SUPERCONDUCTING LEAD. C. A. Shiffman, J. F. Cochran, and M. Garber (Massachusetts Inst. of Tech., Cambridge). Phys. Chem. Solids, 24: 1369-73(Nov. 1963).

The jump in specific heat at the superconducting critical temperature of lead was measured. A value of $(\Delta C)_{T_c} = 57.5 \pm 0.6$ mJ-mole^{-1}-°K^{-1}, which is substantially higher than the previous calorimetric determination by Clement and Quinnell but which is in good agreement with the value obtained by Decker et al., from the temperature dependence of the critical field was found. The result is relevant to the question of the energy dependence of the energy gap parameter $\Delta(\epsilon, T)$ in the BCS theory of superconductivity. It was concluded that $\Delta(\epsilon, T)$ rises with ϵ, for small ϵ, in qualitative agreement with the calculations of Culler et al. (auth)

6106 SEARCH FOR SUPERCONDUCTIVITY IN THE HYDRIDES OF LANTHANUM. M. F. Merriam (Univ. of California, La Jolla) and D. S. Schreiber. Phys. Chem. Solids, 24: 1375-7(Nov. 1963).

Metallic lanthanum hydride samples having atomic ratios H/La of 1.8, 1.96, 2.03, 2.11, 2.15, and 2.36 are not superconducting at 1.1°K. $LaH_{1.98}$ moreover is not superconducting at 0.33°K. Extensive nuclear magnetic resonance measurements made previously by Schreiber on the same samples provide considerable information on their electronic structure. The lack of superconductivity is compatible with the density of states information obtained from the nuclear magnetic resonance data, and is consistent with a split d-band model of the hydrides. It is also consistent with Matthias' empirical rules. (auth)

6107 A FIELD-THEORETIC METHOD IN THE THEORY OF SUPERCONDUCTIVITY. A. Zawadowszki (Central Research Inst. for Physics, Budapest) and G. Pócsik. Phys. Letters, 7: 173-5(Nov. 15, 1963).

Quantum field theory techniques are applied to the Gor-

kov model of superconductivity, and expressions are derived for the chemical potential at zero temperature, the renormalization of the free-particle energy, the excitation energy, and the energy gap. (C.E.S.)

6108 A 25 000 GAUSS, 175 AMPERES Nb-25% Zr WIRE MAGNET FED BY A FLUX PUMP. H. Van Beelen, A. J. P. T. Arnold, H. A. Sypkens, R. de Bruyn Ouboter, J. J. M. Beenakker, and K. W. Taconis (Kamerlingh Onnes Laboratorium, Leiden). Phys. Letters, 7: 175-6(Nov. 15, 1963).

The construction of a Nb–Zr long-wire superconducting magnet using a flux pump is described. The final persistent current is 175 amps. The maximum field reached 25,000 oersteds corresponding to somewhat less than 18 amps per wire, the critical current carrying capacity. The pumping speed for the coil was ~20 gauss per revolution of the rotor, nearly linear over the whole field range. (C.E.S.)

6109 HEAT CONDUCTIVITY OF PURE METALS BELOW 1°K. G. Davey and K. Mendelssohn (Clarendon Lab., Oxford). Phys. Letters, 7: 183-4(Nov. 15, 1963).

Deviations from the linear thermal conductivity curves of Cu, Au, Ti, and Fe were found at temperatures of 0.4–1.0°K. (C.E.S.)

6110 CONSIDERATIONS ON THE MAGNETIC FIELD PROBLEM IN SUPERCONDUCTING THIN FILMS. Yoichiro Nambu (Univ. of Chicago) and San Fu Tuan. Phys. Rev., 133: A1-14(Jan. 6, 1964). (EFINS-63-36)

Results obtained previously on the magnetic field dependence of the energy gap in superconductivity for bulk specimen are adopted to thin-film superconductors using the model of discrete quantization in momentum space. Only the case of parallel and constant external magnetic field along the film surfaces is considered. A series of elementary theorems and some specific calculations lead to the conclusions that a second-order phase transition should be observed at all temperatures for thin film thicknesses, a simple scaling rule exists concerning the field and temperature dependence on the energy gap, and the critical field H_c depends on thickness L and reduced temperature t like $H_c \sim L^{-\frac{1}{2}}[\ln(1/t)]^{\frac{1}{4}}$ for not too thin films ($L \gtrsim 0.5 \times 10^{-6}$ cm). The behavior changes as the film becomes very thin or as the temperature becomes moderately low. A crude comparison with available experimental data seems to bear out the conclusions qualitatively. (auth)

6111 ULTRASONIC SHEAR WAVE ATTENUATION IN SUPERCONDUCTING TIN. J. R. Leibowitz (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 133: A84-96(Jan. 6, 1964).

The superconducting attenuation of transverse ultrasonic waves was studied experimentally in single crystal tin. The residual attenuation was found to be consistent with the relation $\alpha_s/\alpha_n \propto \exp(-E/kT)$ at low reduced temperatures in tin; α_s/α_n is the superconducting-to-normal attenuation ratio and E is the superconducting energy gap. This functional form satisfied the low-temperature observations for all principal propagation and polarization orientations. Anisotropy in the apparent superconducting energy gap was demonstrated. It was found that anisotropy can be associated with polarization orientation as well as propagation orientation of the transverse lattice waves. Observed values of total and residual shear wave attenuation were found to suggest the importance of shear deformation interactions between the electron system and lattice waves in tin. (auth)

6112 FLUXOID QUANTIZATION IN A MULTIPLY-CONNECTED SUPERCONDUCTOR. R. D. Parks and W. A. Little (Stanford Univ., Calif.). Phys. Rev., 133: A97-103 (Jan. 6, 1964).

The transition temperatures of thin-walled superconducting hollow cylinders of very small diameters (approximately 1 μ) were measured as a function of the applied magnetic field in the axial direction. Oscillations with a period of hc/2e in the magnetic flux through the cylinder were observed in the transition temperature T_c. This is a consequence of fluxoid quantization that was originally predicted by Fritz London. The basic unit of magnetic flux hc/2e is explained in terms of London's original arguments and the result from the BCS theory that the charge carriers in a superconductor are pairs of electrons. Measurements were made on Sn, In, Pb, Al, and Sn–In alloys. A periodicity in the magnetic flux of hc/2e was observed in all of the samples. The amplitude of ΔT_c varied from approximately 10^{-5} to 10^{-3}°K and depended upon the temperature, the radius, and the mean free path of the cylindrical sample. (auth)

6113 ANHARMONIC FREE ENERGY OF CRYSTALS AT LOW TEMPERATURES AND AT ABSOLUTE ZERO. Duane C. Wallace (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 133: A153-62(Jan. 6, 1964). (TID-19311)

The method of long waves is used to show that the anharmonic contribution to the Helmholtz free energy of crystals has a lowest order temperature dependence of T^4 at low temperatures. The anharmonic correction to the low-temperature Debye temperature is obtained in terms of the ratio of the anharmonic to harmonic free energies at low temperature. Approximate expressions are developed for the anharmonic zero-point energy for the case where all atoms in the crystal have the same mass. These expressions are shown to be simply related to the corresponding anharmonic contributions to the high-temperature free energy. Numerical evaluation of these approximations is carried out for f-c-c and h-c-p lattices for a model of two-body central forces represented by a Lennard-Jones form. The various contributions to the zero-point energy are compared for these two lattices, and an application to the inert gas crystals shows that the anharmonic contribution is sufficient to make the f-c-c structure stable at T = 0 for Ne and Ar, but not for Kr and Xe. An approximation is developed for the low-temperature anharmonic free energy for the case of one atom per unit cell, and this approximation is evaluated for the f-c-c lattice for the Lennard-Jones model. The results are compared numerically with previously published calculations, and qualitative agreement is found in general. (auth)

6114 SPECIFIC HEAT OF PRASEODYMIUM AND NEODYMIUM METALS BETWEEN 0.4 AND 4°K. O. V. Lounasmaa (Argonne National Lab., Ill.). Phys. Rev., 133: A211-18(Jan. 6, 1964).

The specific heat C_p of praseodymium and neodymium metals was measured between 0.4 and 4°K in a He^3 cryostat. After assuming, on the basis of earlier research, $C_L = 0.554T^3$ (specific heat always given in mJ/mole°K) and $C_E = 10.5T$ for the lattice and electronic specific heats of praseodymium, the remaining C_p was analyzed into a nuclear contribution $C_N = 20.9T^{-2}$ and into a magnetic contribution C_M. If compared with Bleaney's calculations based on fully magnetized electronic states in the metal, the experimental C_N shows that 2.0% of the sample was in a cooperative state, probably ferromagnetic, the rest of the metal being paramagnetic. C_M was further separated into a Schottky contribution with an excited electronic level at 28°K and into a smeared-out cooperative peak with a maximum at 3.2°K. The entropy under the latter curve is

95 mJ/mole °K as compared with the value 0.020 × R ln2 = 115 mJ/mole °K that would be expected as a result of magnetic ordering in 2.0% of the sample. Both C_N and C_M thus suggest that 2% of the sample enters a cooperative phase below 3.2°K. This mechanism to explain C_N and C_M must be considered as preliminary. The value of C_N is rather different from earlier results. A sample-dependent C_N is consistent with the picture of ferromagnetic domains. Below 2°K the specific heat of praseodymium can be written, with 1% accuracy, $C_p = 4.53T^3 + 24.4T + 20.9T^{-2}$. At higher temperatures C_p cannot be represented by a simple power series. The magnetic contribution to the specific heat of neodymium is huge due to cooperative peaks at 7 and 19°K; even at 1°K C_M represents 88% of the total C_p. Below 7°K neodymium is antiferromagnetic. After adopting $C_L = 0.502T^3$ and $C_E = 10.5T$ an analysis gave $C_N = (7 \pm 0.7)T^{-2}$. This value is about 50% smaller than that calculated by Bleaney if full electronic magnetization is assumed. However, the splitting of the electronic levels is rather large in neodymium and one cannot assume that $\langle J_z \rangle$ in a cooperative state tends to $J = \frac{9}{2}$, but rather reaches a lower limiting value at T = 0°K. This explains the smaller experimental C_N. Between 0.4 and 1°K the specific heat of neodymium may be written with 1% accuracy $C_p = 125.7T^3 + 22.5T + 6.4T^{-2}$. The accuracy of these measurements is estimated as 1.5% at 0.4°K and as 0.5% between 1 and 4°K. While checking the performance of the cryostat the specific heat of copper was found to be $C_p = 0.0510T^3 + 0.698T$. (auth)

6115 SPECIFIC HEAT OF LUTETIUM METAL BETWEEN 0.38 AND 4°K. O. V. Lounasmaa (Argonne National Lab., Ill.). Phys. Rev., 133: A219-24(Jan. 6, 1964).

The specific heat of lutetium metal was measured in a He^3 cryostat. Between 0.38 and 4°K (in mJ/mole °K) $C_p = 0.210T^3 + 11.27T + 0.094T^{-2}$. Scatter of individual points from this curve is, except in a few isolated cases, less than 0.5%. The lattice specific heat corresponds to a Debye characteristic temperature $\theta = 210$°K, which is considerably higher than θ's previously assigned to rare earths. The discrepancy is probably due to difficulties in determining θ accurately for those lanthanides that have large magnetic contributions to C_p. On the basis of this and other researches it is suggested that for all trivalent rare earths, θ can be calculated by linear interpolation, as a function of the atomic number, between $\theta = 210$°K for Lu and $\theta = 142$°K for La. An accuracy of ±5°K may be expected. The present value for the coefficient in the electronic specific heat C_E for Lu and previous measurements on La, Sc, and Y suggest that within ±7% accuracy one may write for all trivalent lanthanides $C_E = 10.5T$. The small T^{-2} term in C_p could be caused by interaction of the nuclear quadrupole moment with the crystalline field gradient, or it may be due to long-range exchange-type coupling between the electronic moments of rare-earth impurities in the Lu sample. If the former interpretation is accepted, the electric field gradient, along the symmetry axis, becomes 2.2×10^{24} cm^{-3}. (auth)

6116 MEISSNER EFFECT AND FLUX QUANTIZATION IN THE QUASIPARTICLE PICTURE. Dietrich A. Uhlenbrock and Bruno Zumino (New York Univ., Washington Square). Phys. Rev., 133: A350-61(Jan. 20, 1964).

A superconductor in a magnetic field is studied by means of a generalized quasiparticle transformation. Using the minimum principle for the thermodynamic grand-potential, nonlinear equations are derived for the superconductor, which can be considered valid at finite temperature. For small magnetic potential these equations are linearized and are shown to imply the London formula and the Meissner effect. For a multiply connected superconductor the nonlinear equations are shown to be consistent with Maxwell's equation only if the magnetic flux is quantized in the units predicted by Onsager. (auth)

6117 SPECIFIC HEAT OF CERIUM AND EUROPIUM METALS BETWEEN 0.4 AND 4°K. O. V. Lounasmaa (Argonne National Lab., Ill.). Phys. Rev., 133: A502-9 (Jan. 20, 1964).

The specific heats of cerium and europium metals were measured between 0.4 and 4°K in a He^3 cryostat. For cerium, two experiments were made with samples consisting of 62 and 39% of the α phase, the balance being β cerium. Due to a pronounced peak at 12.5°K the specific heat is quite large already at 4°K. A previously unknown flat anomaly in C_p was found around 0.8°K. By combining these measurements with those of Parkinson and Roberts and by assuming $C_L = 0.612T^3$ and $C_E = 10.5T$ for the lattice and electronic specific heats of the trivalent β phase an analysis gave $C_p = x(0.50T^3 + 21T) + (1 - x)(0.612T^3 + 10.5T + C_M)$. Here x is the fraction of α cerium in the sample and C_M is the magnetic specific heat of the β phase. C_E is thus about twice as large for the quadrivalent α phase as for β cerium. In the former modification $C_M = 0$ because there is no magnetic 4f electron. Since all of the stable isotopes of cerium are even-even nuclei the nuclear specific heat $C_N = 0$. Below 1.2°K the specific heat of europium can be represented with 0.8% maximum deviation from experimental points by $C_p = 27.96T^3 + 6.18T + 2.333T^{-2}$. Above 1.2°K the temperature dependence of C_M gradually becomes less than T^3 and the results no longer can be expressed as a simple power law. This points to an anomaly in C_M, centered probably somewhere between 4 and 10°K. As averages of two least-squares analyses the values $C_E = (5.8 \pm 1.0)T$, $C_N = (2.36 \pm 0.07)T^{-2}$ are adopted. C_E is thus in between the values ~10.5T and 2.9T observed for many trivalent lanthanides and divalent ytterbium, respectively. Europium metal appears to be divalent and the ground state of Eu^{2+} ions is $^8S_{7/2}$. Since the orbital angular momentum of the 4f electrons is zero in an S state, C_N is rather small. The effective magnetic field at europium nuclei becomes $H_{eff} = 260 \pm 4$ kG in excellent agreement with $H_{eff} = 264 \pm 8$ kG deduced recently by Barrett and Shirley from Mössbauer measurements. Another interpretation of the experimental results, suggesting that europium at low temperatures might be a mixture of di- and trivalent phases, is also briefly discussed. (auth)

6118 THE SPECIFIC HEATS BELOW 30°K OF LITHIUM METAL OF VARIOUS ISOTOPIC COMPOSITIONS AND OF SODIUM METAL. J. D. Filby and Douglas L. Martin (National Research Council, Ottawa). Proc. Roy. Soc. (London), Ser. A, 276: 187-203(Nov. 26, 1963).

The specific heats of lithium metal of three different isotopic compositions (main components 99.99 at. % Li^7, 92.7 at. % Li^7 (~ natural) and 99.3 at. % Li^6, respectively) and of sodium metal have been measured in the temperature range 3 to 30°K. The 99.99% Li^7 sample was also measured in the temperature range 0.4 to 1.5°K. Within experimental error the differences in the lattice specific heats of the lithium samples are in accord with theoretical expectation. The values of the Debye temperatures in the low-temperature limit are 337.0 ± 2.5°K for 99.99% Li^7, 344.0 ± 2.5°K for 92.7% Li^7, and 367.5 ± 2.5°K for 99.3% Li^6. However, the temperature variation of the lattice specific heats of all the lithium samples is anomalous, because the usual minimum in the Debye temperature as a function of temperature is not observed. Both lithium and

sodium undergo a martensitic transformation on cooling to the temperature range of the experiments. It was found that the amount of lithium transformed to the low-temperature phase is not increased appreciably by cooling below 20°K, whereas the amount of sodium transformed is significantly increased on cooling below this temperature. After rapid cooling of the sodium sample to 3°K, spontaneous heating is observed in the temperature range 4 to 16°K, the total heat emitted being about 0.05 cal/g atom. This is believed to correspond to annealing out of some of the defects introduced by the martensitic transformation. By thermally cycling the sodium sample up to 90°K and back to 3°K, the martensitic transformation was partially inhibited and the specific heats below 30°K of the separated b.c.c. and h.c.p. phases were deduced, the low temperature limiting Debye temperatures being about 152.5 and 159°K, respectively. (auth)

6119 ANISOTROPIC SUPERCONDUCTORS WITH NON-MAGNETIC IMPURITIES. P. Khokhenberg (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1208-17(Oct. 1963). (In Russian)

The properties of weakly anisotropic superconductors containing nonmagnetic impurities are studied and the dependence of the critical temperature, the energy gap, and the spin-lattice relaxation time on impurity concentration is found. The influence of impurities on the density of states as a function of energy and direction is investigated. It is shown that impurities lead to isotropization of the density of states at relatively low concentrations. (auth)

6120 EFFECT OF PRESSURE ON THE SUPERCONDUCTIVITY TRANSITION TEMPERATURE OF Nb_3Sn AND Nb–Zr ALLOYS. E. S. Itskevich, M. A. Ilina, and V. A. Sukhoparov (Inst. of High-Pressure Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1378-9 (Nov. 1963). (In Russian)

The effect of uniform compression on the temperature of transition to the superconducting state in the alloys Nb_3Sn and Nb–Zr is investigated. In Nb_3Sn the dependence of ΔT_c on p at pressures above ~3000 atm. is quadratic. The superconductivity transition temperature in Nb–Zr was found to increase under the action of pressure. (auth)

6121 CONTRIBUTION TO THE THEORY OF QUANTIZATION OF THE MAGNETIC FLUX IN SUPERCONDUCTORS. L. P. Rapoport (Voronezh State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 45: 1453-5(Nov. 1963). (In Russian)

A microscopic theory of quantization of the magnetic flux through a superconducting cylinder is developed. The relation between this phenomenon and quantum vortexes in a fermion system is indicated. Corrections to the magnitude of the magnetic flux quantum due to the size of the apparatus and magnitude of the energy gap are obtained. (auth)

6122 A MICROSCOPIC DEDUCTION OF THE GINSBURG–LANDAU EQUATION FOR AN ANISOTROPIC SUPERCONDUCTOR. L. P. Gorkov and T. K. Melik-Barkhudarov (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1493-8(Nov. 1963). (In Russian)

A microscopic deduction of the Ginsburg–Landau equation for an anisotropic superconductor is presented. The meaning of the constants encountered in the phenomenological theory and defined in terms of the gap values at absolute zero is elucidated. (auth)

6123 SUPERCONDUCTORS. Proceedings of Technical Sessions Sponsored by the Electronic Materials Committee of the Institute of Metals Division, The Metallurgical Society, American Institute of Mining, Metallurgical, and Petroleum Engineers, New York, Feb. 18, 1962. M. Tanenbaum and W. V. Wright, eds. New York, Interscience Publishers, 1962. 159p.

The events leading to the present status of superconductivity are reflected in the 13 papers presented. All were chosen for NSA except for one that was previously abstracted. Some aspects treated are tunneling, high-field superconductivity, impurity effects, critical currents, and properties of specific materials. (R.E.U.)

For abstracts of individual papers see: 6124, 6125, 6126, 6127, 6128, 6129, 6130, 6131, 6132, 6133, 6134, and 6135.

6124 METALLURGY FROM SUPERCONDUCTIVITY. B. T. Matthias (Univ. of California, La Jolla and Bell Telephone Labs., Inc., Murray Hill, N. J.). p.1-8 of "Superconductors." New York, Interscience Publishers, 1962.

The close relation of metallurgy to superconductivity is discussed. Examples are described that illustrate the metallurgical insight obtained from studies of superconductivity. (R.E.U.)

6125 SOME ASPECTS OF TUNNELING INTO SUPERCONDUCTORS. Ivar Giaever (General Electric Co., Schenectady, N. Y.). p.9-24 of "Superconductors." New York, Interscience Publishers, 1962.

The principle of electron tunneling is explained using simple energy diagrams of the metals both in the normal and superconducting state. The technique was used on several different superconductors, and except for a few small divergences the experimental results support the Bardeen-Cooper-Schrieffer theory. (auth)

6126 THE ONSET OF HIGH MAGNETIC FIELD SUPERCONDUCTIVITY IN ALLOYS. D. P. Seraphim (International Business Machines Corp., Yorktown Heights, N. Y.). p.25-34 of "Superconductors." New York, Interscience Publishers, 1962.

The electron mean free path is found to be critical in determining the solute composition at which high magnetic field superconductivity appears in indium base solid solutions. This critical electron mean free path is $\ell = 440 \pm 100$ A ($\rho = 1.3 \pm 0.3$ μohm cm) quite independent of the particular nature of the solute for the six solutes tested in indium. It may be inferred that for $\ell < 440 \pm 100$ A the interfacial (normal metal-superconducting metal) energy, Δ_s, becomes negative at all temperatures, in qualitative agreement with the theory of Gorkov and Abrikosov. And it is suggested that in impure metals, when Δ_s becomes negative, dislocations and other structural defects act as low energy sites for the superconducting phase. Thus, both intrinsic properties, electronic mean free path, electronic specific heat, etc., and structural properties, dislocations, etc., are significant in the preparation of high magnetic field superconductors. (auth)

6127 METALLURGICAL ASPECTS OF HIGH-FIELD SUPERCONDUCTING MATERIALS. J. H. Wernick (Bell Telephone Labs., Inc., Murray Hill, N. J.). p.35-52 of "Superconductors." New York, Interscience Publishers, 1962.

The effect of cold working and heat treatment of ductile superconductors on the current carrying capacity in high magnetic fields is reviewed. Information concerning the effect of some powder metallurgical variables on the superconducting properties of Nb–Sn core wire is presented. The temperature variation of the critical field of the filaments at low current densities, for a number of superconductors is also discussed. (auth)

6128 HIGH-FIELD SUPERCONDUCTING CHARACTERISTICS OF SOME DUCTILE TRANSITION METAL ALLOYS. R. R. Hake, T. G. Berlincourt, and D. H. Leslie (Atomics International, Canoga Park, Calif.). p.53-9 of "Superconductors." New York, Interscience Publishers, 1962.

Critical current densities, J_c, for restoration of observable resistance were measured in 22 ductile superconducting alloys in the binary transition metal systems Ti–V, Nb–Zr, Zr–Mo, Ta–Hf, Ti–Nb, Ti–Mo, Nb–Sc, Ti–Ta, and Nb–Hf. All of these alloys exhibit zero resistance in transverse magnetic fields of 30 kgauss, and 14 of the alloys display J_c (30 kgauss, 4.2°K) values in the 10^3 to 10^4 amp/cm^2 range after cold rolling to reductions of 65 to 92%. The cold rolling increases J_c (30 kgauss) values by factors of about 2 to 90 over those observed in as-cast alloys and generally results in a marked dependence of J_c on the orientation of a transverse magnetic field such that J_c (30 kgauss) increases by factors of 2 to 35 when the field is rotated from a position perpendicular to a position parallel to the rolling plane. In four of the alloys J_c at high fields is observed to increase with increase in the applied field. (auth)

6129 METALLURGICAL ASPECTS OF SUPERCONDUCTING NIOBIUM–ZIRCONIUM ALLOYS. James Wong (Wah Chang Corp., Albany, Ore.). p.83-97 of "Superconductors." New York, Interscience Publishers, 1962.

The niobium–zirconium phase diagram is briefly reviewed with emphasis in the ranges of composition having applications for the superconducting high magnetic field solenoids. Data are presented, which indicate that for alloys up to 33%–zirconium the current density is approximately the same value at fields below the "knee." Indications are that similar behavior could be expected for the higher zirconium alloys as well. Apparently, heat treatment, together with cold working, can result in large increases of I_c, but for commercial material within the composition studied, similar increases of this order of magnitude are not observed. It appears that in both cases, niobium–zirconium alloys seem to approach a limiting I_c versus H_c curve. Experiments are described in which various intermediate heat treatments and annealing studies with and without subsequent cold working were conducted to optimize the I_c and H_c values for commercial material. The influence of these heat treatments on the magnetic properties are also correlated to hardness data and metallographic studies. (auth)

6130 FIELD-DEPENDENT ANISOTROPY OF THE CRITICAL CURRENT IN Nb–Zr ROLLED STRIP. M. S. Walker and M. J. Fraser (Westinghouse Electric Corp., Pittsburgh). p.99-113 of "Superconductors." New York, Interscience Publishers, 1962.

Critical current was measured in specimens cut from a rolled Nb–25% Zr single crystal and from heat-treated and as-rolled Nb–30% Zr polycrystalline strip. Measurements were made as a function of specimen orientation to a magnetic field on specimens cut from the strip at various angles to the rolling direction. A field-dependent anisotropy in critical current was found for all of the specimens with critical current a maximum for fields parallel to the rolling plane. Differences in this field dependence were evident for the three materials. Consideration of the microstructure, rolling texture, and superconducting properties of these materials leads to the hypothesis that filaments are boundaries that behave as thin films. (auth)

6131 ANOMALOUS CRITICAL CURRENTS IN NIOBIUM-25 ATOMIC % ZIRCONIUM WIRE. Paul R. Aron and Harley C. Hitchcock (Univ. of California, Berkeley). p.115-21 of "Superconductors." New York, Interscience Publishers, 1962.

Measurements of the superconducting critical current as a function of applied transverse magnetic field were made on niobium-25 atomic % zirconium alloy wire that was heat treated at a stage of its cold reduction. There is a peak in the critical current as a function of treatment temperature, consistent with the result of Kneip, Betterton, Easton, and Scarbrough. A broad maximum in critical current, of the type reported by Berlincourt, Hake, and Leslie in niobium-12 atomic % zirconium alloy was found at magnetic fields between 20 and 70 kgauss for the higher treatment temperatures. The critical currents for drawn samples of the heat-treatment control wire were measured, and a diameter-squared dependence for the critical current was found for fields to 50 kgauss. The critical current vs applied magnetic field curves are related to a simple model of the conduction process. (auth)

6132 PREPARATION AND PROPERTIES OF ULTRAFINE NIOBIUM–ZIRCONIUM SUPERCONDUCTING WIRE. K. M. Olsen, R. F. Jack, E. O. Fuchs, and F. S. L. Hsu (Bell Telephone Labs., Inc., Murray Hill, N. J.). p.123-8 of "Superconductors." New York, Interscience Publishers, 1962.

Niobium–zirconium superconductive alloys can be cold drawn to 0.001 in. dia. and less by techniques involving cladding with stainless steel. Superconductive measurements in magnetic fields indicate that current carrying capacity in fields up to 70 kgauss markedly increases with decrease in wire size. (auth)

6133 ANISOTROPY OF THE TRANSITION FIELD IN RHENIUM SINGLE CRYSTALS. J. J. Hauser (Bell Telephone Labs., Inc., Murray Hill, N. J.). p.129-33 of "Superconductors." New York, Interscience Publishers, 1962.

Single crystals of Re with a resistivity ratio of approximately 1500 were grown by the floating zone technique. The crystals were subsequently deformed in tension. Samples were selected where the deformation took place primarily on one prismatic slip system, i.e., on the $\{10\bar{1}0\}$ slip plane along the $(\bar{1}2\bar{1}0)$ slip direction. Measurements of the resistance were made to determine the variation of the critical current with applied magnetic field. The deformed samples revealed an anisotropy in their transition field (transition from the superconducting to normal state) increasing with decreasing current. The transition field was a minimum when the field was perpendicular to the active slip plane. The low current anisotropy disappeared upon annealing at high temperature and only the demagnetization effects remained. These results can be explained in terms of the anisotropic dislocation density introduced by this particular deformation. (auth)

6134 THE INTERMEDIATE STATE OF SOME HARD SUPERCONDUCTORS. V. Arp, R. Kropschot, and T. S. Craig (National Bureau of Standards, Boulder, Colo.). p.135-41 of "Superconductors." New York, Interscience Publishers, 1962.

A superconducting wire in an external magnetic field is driven into the intermediate state by the application of a current not far greater than the critical value for that field. At all but the lowest currents, Joule heating then warms the wire very quickly, and the full normal resistance is restored. Experiments are described in which the sample voltage is monitored during the application of a square pulse of current. The resulting intermediate state resistance can be separated from the Joule heating effects originating either at the current contacts or uniformly

along the length of the wire. In general the intermediate states for niobium, niobium–zirconium, and Nb_3Sn wire are found to extend over a wide range of field and current, probably indicating the existence of superconducting domains having a wide range of critical current-field characteristics. (auth)

6135 THE NIOBIUM–TIN SYSTEM: STABILITY RANGES AND SUPERCONDUCTING PROPERTIES OF Nb_2Sn_3 AND Nb_3Sn_2. T. B. Reed, H. C. Gatos, W. J. LaFleur, and J. T. Roddy (Massachusetts Inst. of Tech., Lexington). p.143-9 of "Superconductors." New York, Interscience Publishers, 1962.

Two new niobium–tin compounds were synthesized. The compound Nb_2Sn_3 is tetragonal with a = 11.304 A and c = 5.013 A; it exhibits no sharp superconducting transition temperature above about 4.2°K. The compound Nb_3Sn_2 is tetragonal with a = 6.901 A and c = 9.533 A; it exhibits a superconducting transition at 16.6°K. The temperature and composition stability ranges of these compounds and of Nb_3Sn are discussed. (auth)

Neutron Physics

6136 (ANL-6787) TRANSPORT SOLUTIONS TO THE MONOENERGETIC CRITICAL PROBLEMS (thesis). George J. Mitsis (Argonne National Lab., Ill.). Nov. 1963. Contract W-31-109-eng-38. 170p.

Transport solutions to the monoenergetic plane, spherical, and cylindrical critical problems with isotropic scattering are developed by the method of singular expansion modes. The results are given in the form of exact expressions for the neutron distributions and criticality conditions. These expressions depend on expansion coefficients that are shown to satisfy Fredholm integral equations of the second kind. Successive approximations on the coefficients lead to the asymptotic results of diffusion theory as well as to easily accessible transport corrections. The expansions for the neutron distributions are derived by two different, but equivalent, methods. In the first method a three-dimensional expansion for the angular density is developed from the elementary solutions of the transport equation and then specialized to the desired geometry. For problems with plane symmetry, the resulting expression are used directly to determine the expansion coefficients, whereas in spherical and cylindrical geometries the specialization of the three-dimensional solutions yields a variety of representations for the respective angular densities. The second method consists of replacing the angular distributions by suitable density transforms and then determining the transforms completely with the aid of the integral equations for the neutron densities. In plane geometry this method leads to the conversion of the transport equation to a singular integral equation for the angular density. In spherical and cylindrical geometries the appropriate transforms are shown to satisfy separable equations whose solutions can be represented by unique expansions in terms of complete sets of singular expansion modes. The coefficients in the transform expansions are determined by resulting side conditions and the actual neutron distributions established by simple inversions. Although emphasis is on obtaining exact expressions for the neutron distributions and criticality conditions, the results are illustrated by approximate expressions and computations. (auth)

6137 (NP-13447) OB ISSLEDOVANII POVEDENIYA TEPLOVYKH NEITRONOV V KONECHNYKH SREDAKH METODOM CHASTOTNOI KHARAKTERISTIKI. (On the Investigation of Thermal Neutron Behavior of Finite Media by a Method of Frequency Characteristics). I. I. Purika (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). Apr. 1963. 17p.

In reviewing earlier studies on the behavior of thermal neutrons in finite moderating or multiplying media by statistical or pulsed-source methods, it was found that the frequency-characteristic method of a modulated source yields the same information on the nuclear properties of the system. The pulse characteristics are related to the frequency characteristics through a Fourier transform. Theoretical difficulties encountered in the solution of the Boltzmann integral-differential equations made it necessary to carry out experimental studies. For the specific case of the frequency-characteristic method it was assumed that the neutron flux is measured at the same position by means of a detector modulated by a flux with a frequency $\omega/2\pi$, irradiated for a time interval $Q2\pi/\omega k$. The method requires a lower flux than the pulsed source method and may be employed at any reactor. (TTT)

6138 (ORNL-3499(Vol.I)) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 1, 1963. (Oak Ridge National Lab., Tenn.). Dec. 10, 1963. Contract W-7405-eng-26. 221p.

Separate abstracts were prepared for forty of the sixty-two sections in the report. Three papers included were previously abstracted for NSA. (D.C.W.)

For abstracts of individual sections see: 5473, 5474, 5632, 5633, 5634, 5635, 5723, 5724, 5913, 5967, 5968, 5969, 5971, 5972, 6139, 6140, 6141, 6142, 6143, 6144, 6145, 6146, 6147, 6172, 6173, 6174, 6175, 6176, 6177, 6178, 6179, 6404, 6405, 6406, 6407, 6462, 6523, 6524, 6525, and 6526.

6139 (ORNL-3499(Vol.I)(p.33-9)) STATUS OF PULSED-NEUTRON MEASUREMENTS OF NEUTRON-DIFFUSION PARAMETERS FOR ICE. E. G. Silver (Oak Ridge National Lab., Tenn.).

The quality of the data in the measurement of the temperature dependence of the diffusion parameters of thermal neutrons in ice was improved, and a technique for growing the required small air-free ice bodies was developed. Neutron yield calibrations were performed with a long counter, and a maximum source strength of about $(2.3 \pm 0.1) \times 10^7$ neutrons/μamp of beam current at 300 kev was found for the D-T reaction. About 70% of the measurements were completed, and the data were analyzed by the Cornell method. (auth)

6140 (ORNL-3499(Vol.I)(p.57-8)) MEASUREMENT AND CALCULATION OF THE PROMPT-NEUTRON DECAY CONSTANT AND EFFECTIVE BUCKLING AS A FUNCTION OF SIZE FOR HOMOGENEOUS URANIUM SOLUTIONS. D. W. Magnuson (Oak Ridge National Lab., Tenn.).

Flux distributions and prompt neutron decay constants were measured for a uranyl nitrate solution with a concentration of about 65g U/l and an enrichment of 93.2%. Both critical and subcritical systems were used in cylindrical and spherical geometries. The measured values for spheres are in fair agreement with values calculated with the DSN transport code. (auth)

6141 (ORNL-3499(Vol.I)(p.68)) DSN TRANSPORT CALCULATIONS OF CRITICAL SPHERES ON URANIUM SOLUTIONS. D. W. Magnuson (Oak Ridge National Lab., Tenn.).

The DSN transport code was used to calculate multipli-

cation factors for spheres with experimentally determined critical uranium concentrations. The spheres ranged from 11.68 to 61.01 cm in radius, and both U^{233} and U^{235} enriched solutions with and without water reflectors were used. (auth)

6142 (ORNL-3499(Vol.I)(p.69-76)) PRELIMINARY CALCULATIONS AND PREPARATIONS FOR A ONE-DIMENSIONAL CRITICAL-ASSEMBLY EXPERIMENT. E. G. Silver and E. B. Johnson (Oak Ridge National Lab., Tenn.).

Calculations leading to the design parameters for a one-dimensional critical assembly experiment were completed. Experiments with the fuel and water regions varying in one direction will be compared with one-dimensional calculations. (auth)

6143 (ORNL-3499(Vol.I)(p.108-15)) MEASUREMENTS OF FAST-NEUTRON TRANSPORT IN WATER BY TIME-OF-FLIGHT TECHNIQUES. V. V. Verbinski (Oak Ridge National Lab., Tenn.), J. Kirkbride, P. Phelps, and J. C. Courtney (General Atomic Div., General Dynamics Corp., San Diego, Calif.).

Pulsed neutrons from electron beam reactions with lead targets were used to study the leakage spectra of neutrons penetrating slabs of water from 0 to 40 cm thick. Measurements were made with small and large sources to obtain leakage spectra through 30 cm of water at scattering angles of 0, 2, and 4° and as a function of slab thickness at 0 and 30°. (auth)

6144 (ORNL-3499(Vol.I)(p.116-18)) MONTE CARLO CALCULATIONS OF FAST-NEUTRON PENETRATION IN LITHIUM HYDRIDE. F. H. S. Clark, F. B. K. Kam, and N. A. Betz (Oak Ridge National Lab., Tenn.).

Monte Carlo calculations of the penetration of LiH by fission neutrons were performed with the 05R program. A disk source 24 cm from an infinite LiH slab and from conical LiH shields with and without LiH collars were the geometries used. The results for the LiH slab indicate a fission neutron relaxation length about 10% less than previous moments calculations. The results for the shield with the collar support the feasibility of certain SNAP program experiments. (auth)

6145 (ORNL-3499(Vol.I)(p.118-27)) THE 1/A SOLUTION TO THE BOLTZMANN EQUATION FOR A HEAVY MEDIUM AND COMPARISON WITH OTHER METHODS. R. E. Maerker (Oak Ridge National Lab., Tenn.).

By expanding the scattering integral in the Boltzmann equation through terms of 1/A, where A is the mass number, solutions are readily obtained for the slowing down density for the case of a plane isotropic monoenergetic source in a heavy, infinite medium. Isotropic elastic and no inelastic scattering are assumed. Numerical results from this theory are compared with those from age theory and a Monte Carlo calculation for a 2.5-Mev source in carbon. (auth)

6146 (ORNL-3499(Vol.I)(p.155-9)) MEASUREMENTS OF DOSE RATES RESULTING FROM FAST-NEUTRON SCATTERING IN BERYLLIUM, CARBON, ALUMINUM, AND IRON. F. J. Muchenthaler, K. M. Henry, V. V. Verbinski, M. S. Bokhari, J. J. Manning, J. L. Hull, and D. R. Ward (Oak Ridge National Lab., Tenn.).

The scattering of fast neutrons from cylindrical samples of Be, C, Al, and Fe suspended in a collimated beam from the Tower Shielding Reactor II was measured for scattering angles of 45, 90, and 135° with respect to the beam-sample axis. Measured scattered dose rates are compared with values calculated by ORNL and by Atomics International. (auth)

6147 (ORNL-3499(Vol.I)(p.159-61)) MONTE CARLO CALCULATIONS OF NEUTRON SCATTERING FROM CYLINDERS OF BERYLLIUM, CARBON, ALUMINUM, AND IRON. F. B. K. Kam, F. H. S. Clark, and J. G. LaTorre (Oak Ridge National Lab., Tenn.).

Monte Carlo calculations of the scattered/incident dose and flux ratios for the elements and geometry of the preceding section were made with 05R programs. The results are compared with experimental data and similar calculations. (D.C.W.)

6148 EIGENVALUE PROBLEM IN THE NEUTRON THERMALIZATION. Hiroshi Takahashi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 944-52(Nov. 1963). (In Japanese)

Eigenvalue problems in time and space dependent thermalization transport equations are summarized. They are important in analysis of time decay constant λ and diffusion length $1/\kappa$ measurements. A study of the Wigner-Wilkins type differential equation for the proton gas moderator indicates the existence of an infinite number of discrete time dependent eigenvalue λ_k in the range $0 \leq \lambda_k < (\nu\Sigma)_{min}$ and of a continuous eigenvalue λ in the range $(\nu\Sigma)_{min} < \lambda$, which has a singular eigenfunction. A method of singular integral equation is used in order to prove the existence of the singular eigenfunction in the case of more general scattering kernel. They are compared with an expansion method of a flux in terms of polynomials of energy or of velocity. A boundness of time eigenvalues of infinite and finite medium are illustrated for both cases of monoenergetic neutron and thermalizing neutron. The relevance of Boltzmann transport equation is studied for the very slow neutron. Finally the discussion of the spacial eigenvalue problem is added. (auth)

6149 INCOHERENT INELASTIC NEUTRON SCATTERING AND SELF-DIFFUSION. Robert Zwanzig (National Bureau of Standards, Washington, D. C.). Phys. Rev., 133: A50-1(Jan. 6, 1964).

The cross section for incoherent inelastic scattering of neutrons by a many-body system is shown to be related to the real part of a generalized self-diffusion coefficient. The latter quantity is defined as the transport coefficient in the extension of Fick's law of diffusion to arbitrary space-time variations of the driving force. The derivation is based on the fluctuation-dissipation theorem, in a form given by Kubo, and on a treatment of conventional self-diffusion due to Montroll. Previous results, given by Vineyard and by Singwi, Sjölander, and Rahman, are shown to be special cases of the present result. (auth)

6150 AVERAGE NEUTRON TRANSMISSION IN THE kev REGION. J. E. Lynn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 82: 903-13(Dec. 1, 1963).

The theory of averaging neutron transmission over an energy interval, in which the nuclear cross section contains many resonances, is outlined. Particular consideration is given to the validity of assuming the single-level Breit-Wigner formula for the resonances in carrying out the averaging. Hibdon's data on the average transmission of neutrons through slabs of U^{238} and Th^{232} are analyzed in order to extract the p-wave neutron strength functions. The values for $\Gamma_n^{(1)}/D$ are $(2.5 \pm 0.4) \times 10^{-4}$ and $(2.40 \pm 0.36) \times 10^{-4}$, respectively. (auth)

6151 P_N CALCULATIONS FOR THE CLASSROOM. G. R. Dalton (Univ. of Florida, Gainesville). 28p. (CONF-39-106)

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

The first device used to expedite the numerical evaluation using the analytical approach by hand is a table of characteristic roots ν_j for the various P_N approximations and various values of the scattering-to-total cross-section ratio. From this table all of the exponents in the characteristic functions can be determined for each of the media in the problem. The next tool used is a table of coupling coefficients $G_N(\nu_j)$ which relate the coefficients of the exponential terms in the scalar flux expansion to the coefficients of the expansions of the higher angular moments. A two adjacent semi-infinite media problem is considered. The only constants to be determined are the unknown coefficients A_j and the B_j. Since alternate members of the ν_j are greater than zero and grow without bound as x goes to minus infinitely, the half of the A_j and similarly half of the B_j must be zero. The boundary conditions at the x = zero interface leads to the system of (N + 1) linear equations in the A_j and B_j. Once all of the coefficients A_j and B_j are determined a digital computer program is used for solving systems of linear equations too tedious for convenient hand solution. The final job of evaluating the flux $\phi(x,\mu)$ for various values of x and u is then simply a problem in matrix multiplication and is done on a desk calculator or even with a slide rule for the P_3 problem. Several such problems were carried out using this method yielding complete results with only minor difficulties. Intermediate and final numerical results are presented for one P_3 case. (auth)

6152 NEUTRON GENERATOR. V. A. Emel'yanov and L. I. Beskin. Russian Patent 154,623. Oct. 14, 1963. Filed Sept. 21, 1962.

A neutron generator containing a stationary cylinder with beryllium targets and a cylinder with an α emitter is described. The two cylinders are arranged coaxially. To achieve pulsed operation of the generator, the α-emitter cylinder is fixed and a movable cylindrical shield, with openings along its generatices, is provided. The shield is located between the first two cylinders coaxially to them. (OTS)

Nuclear Properties and Reactions

6153 (AHSB(S)-R-62) A COMPILATION OF NUCLEAR DATA FOR NATURAL ZIRCONIUM. P. J. Hemmings (United Kingdom Atomic Energy Authority. Health and Safety Branch, Risley, Lancs, England). 1963. 25p.

A compilation of data on neutron cross sections for natural zirconium is presented. Total and partial cross sections are presented for 0.1 ev to 100 Mev. The data were compiled using IBM 704 and 7090 punched cards. (R.E.U.)

6154 (ANL-6756) CALCULATIONS OF YIELDS OF PRODUCTS IN HIGH-FLUX NEUTRON IRRADIATIONS OF HEAVY ELEMENT SAMPLES. J. Milsted, P. R. Fields, and D. N. Metta (Argonne National Lab., Ill.). Aug. 1963. Contract W-31-109-eng-38. 22p.

Calculations have been made of the build-up of higher nuclides in samples of various heavy-element starting materials, at neutron fluxes ranging from 4×10^{13} to 1×10^{16} n/cm^2/sec, including the flux expected from the HFIR reactor at Oak Ridge (namely, 5×10^{15} n/cm^2/sec). Attempts have been made to estimate yields of the heavier fermium isotopes and of Md^{259} by means of the nuclear properties predicted from systematics. The results indicate that it may be possible to detect Md^{259} in the products of californium irradiated in HFIR, and that a further two-fold increase in flux would increase the yields of the heaviest nuclides considerably. (auth)

6155 (AWRE-O-82/63) NEUTRON CROSS SECTIONS OF U^{235} AND U^{238} IN THE ENERGY RANGE 1 kev–15 Mev. PART II. BEST CROSS SECTIONS FOR U^{235} BASED ON MICROSCOPIC EXPERIMENTAL & THEORETICAL DATA AVAILABLE AT MARCH 1962. K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1963. 106p.

Recommended values are given for neutron total and partial cross sections of U^{235} in the energy range 1 kev to 15 Mev. The available experimental evidence is supplemented by estimates based on nuclear theory. Details of energy and angular distributions are given so that the data are complete for the purposes of neutronics calculations. Experimental and theoretical data that have become available since the values were determined are discussed as far as possible. (auth)

6156 (CONF-354-1) NEUTRON EXPERIMENTS WITH A TANDEM ACCELERATOR. H. H. Barschall (Wisconsin. Univ., Madison). [1963]. Contract AT-11-1-GEN-7. 34p.

From Accelerator Conference, Boston, Mass., Nov. 1963.

The Wisconsin tandem accelerator is used part of the time for experiments in neutron physics. In these experiments the properties of neutrons from charged-particle reactions as well as the interaction of neutrons with nuclei are studied. Some of the techniques used and some of the results obtained are described. (auth)

6157 (HW-77344) CALORIMETRIC DETERMINATION OF THE DECAY ENERGY OF PROMETHIUM-147. E. J. Wheelwright, D. M. Fleming, and F. P. Roberts (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 30, 1963. Contract AT(45-1)-1350. 7p.

The Pm^{147} decay energy has been measured calorimetrically using two independently prepared one-thousand-curie sources of highly purified Pm_2O_3. The results are self-consistent and are in substantial agreement with the value calculated from the beta energy spectrum. Values of 0.330 and 0.331 watt/gram Pm^{147} are determined. (auth)

6158 (JINR-P-1320) PRIMENENIE KONFORMNOGO OTOBRAZHENIYA PLOSKOSTI LOBACHEVSKOGO NA EVKLIDOVU POLOCU K KINEMATIKE RELYATVISTSKIKH CHASTITS. (The Application of the Conformal Mapping of the Lobachevski's Plane on the Euclidean Band to the Kinematics of the Relativistic Particles). E. G. Bubelev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 34p.

The conformal mapping of the plane in the Lobachevsky velocity space on the Euclidean band is considered. The mapping allows one to get the velocity plot of relativistic particles produced in high-energy nuclear reactions. Using the velocity-plot it is easy to reveal the characteristic kinematic features of such reactions. The velocity-plot and a moving coordinate net make it possible to solve quickly various problems of relativistic kinematics. Some typical examples are treated. (auth)

6159 (LADC-5990) THERMAL NEUTRON CAPTURE IN D AND O^{16}. E. T. Jurney and H. T. Motz (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 11p. (CONF-346-2)

From International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., Oct. 1963.

The analytical and experimental apparatus and procedures used in the determination of thermal neutron capture cross sections of low-z nuclei by direct observation of the capture gamma ray spectra are described. A detailed ac-

count of the D and O^{16} measurements, for which D_2O targets were used, is given; and results for Be^9, C^{12}, and N^{14} are tabulated. (D.C.W.)

6160 (NP-13326) USTANOVKA DLYA ISSLEDOVANIYA EFFEKTA MESSBAUERA. (Device for Studying Mossbauer Effect). K. P. Aleshin, I. I. Lukashevich, B. N. Samoilov, V. V. Sklyarevskii, E. P. Stepanov, and N. I. Filippov (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). 1963. 15p.

Investigations were made of the Mossbauer effect using a special electrodynamic vibrator starter in which a triangle or voltage from a generator suppled a vibration coil at a constant rate. Variable velocities from 0 to 6 cm/sec were achieved by varying the generator amplitudes. Both absorption and scattering were measured. The characteristics of the device was checked using the Mossbauer spectrum of Fe^{57} in Fe_2O_3. (tr-auth)

6161 (NP-13346) CONSTRUCTION ET ETUDE DE DETECTEURS A JONCTION A BARRIERE DE SURFACE AU Si UTILISABLES DANS LA RECHERCHE SUR LES REACTIONS (n,α). APPLICATION DES DETECTEURS A SEMI-CONDUCTEURS A LA MESURE DU FLUX DE NEUTRONS RAPIDES PAR LA METHODE DE LA PARTICULE ASSOCIEE (THESE). (Design and Construction of Silicon-Junction Surface-Barrier Detectors Utilized in the Study of (n,α) Reactions. Application of Semi-Conductor Detectors to the Measurement of Fast Neutron Flux by the Method of Associated Particles (thesis)). Bernard Duborgel (Lyon. Université). 1962. 58p.

The design and construction of surface-barrier semiconductor detectors suitable for use in neutron-reaction studies is presented. The performance of these detectors in the reactions $Si^{28}(n,\alpha)$ and $Si^{29}(n,\alpha)$ and in recording the α line of Po^{210} is shown. Methods for stabilizing these counters are described. Radiation and ambient-atmosphere effects on the deterioration of both surface-barrier and diffusion-junction counters is determined. The use of these detectors, in conjunction with the associated-particle method, to determine the neutron fluxes from DD and DT reactions is described. (T.F.H.)

6162 (NP-13348) UNE METHODE SIMPLE D'ETUDE DE LA POLARISATION ET DE LA DISTRIBUTION ANGULAIRE DANS UN TYPE PARTICULIER DE REACTIONS DE STRIPPING (THESES). (A Simple Method of Study of the Polarization and Angular Distribution in Particular Type of Stripping Reaction (thesis)). Edgar El-Baz (Lyon. Université). 1963. 129p.

The (d,p) reaction is studied using a formalism in which the incoming and outgoing particles are represented by plane waves, and the interaction between the outgoing proton and the residual nucleus is represented by a "complementary" interaction. This complementary interaction may depend on spin-orbit coupling, and can thus be used to explain polarization effects. This model is used to analyze the reaction $Si^{29}(d,p)Si^{30}$. (T.F.H.)

6163 (NP-13349) UTILISATION DES DETECTEURS A JONCTION AU SILICIUM POUR L'ETUDE DES REACTIONS NUCLEAIRES (n,α) APPLICATION AUX REACTIONS $Si^{28}(n,\alpha)Mg^{25}$ ET $Si^{29}(n,\alpha)Mg^{26}$ (THÈSE). (Utilization of Silicon-Junction Detectors for Study of Nuclear Reactions (n,α). (Application to the Reactions $Si^{28}(n,\alpha)Mg^{25}$ and $Si^{29}(n,\alpha)Mg^{26}$ (thesis)). Gérard Grenier (Lyon. Université). 1962. 62p.

A Si-junction radiation detector is described. The use of this type of detector for measuring neutron fluxes by the associated-particle method, and for analyzing the (n,α) reaction on Si^{28} and Si^{29}, is detailed. The accuracy and resolution in these applications is discussed. (T.F.H.)

6164 (NP-13354) ETUDE DE L'EFFET DES LIAISONS CRISTALLINES DANS LES REACTIONS NUCLEAIRES INDUITES PAR DES NEUTRONS DE BASSE ENERGIE PRES D'UN NIVEAU DE RESONANCE (THESE). (Study of the Effect of Crystalline Bonds on Nuclear Reactions Induced by Neutrons of Low Energy Near Resonance Levels (thesis)). C. L. M. Le Pipec (Lyon. Université). 1963. 85p.

The effects of crystal structure on the deformation of resonance curves in low-energy neutron-induced nuclear reactions are studied theoretically, and the results are verified experimentally for Au^{197} in Au and W^{183} in W by studying the low-energy resonance levels. (T.F.H.)

6165 (NP-13359) NEITRONOSPEKTROSKOPICHESKII ISSLEDOVANIYA. IU. PODNYE NEITRONNYE SECHENIYA IZOTOPOV TSIRKONIYA V OBLASTI ENERGII DO 20000 EV. (Neutrono Spectroscopic Studies of Nuclear Levels. IV. Total Neutron Cross Sections of Zirconium Isotopes at Energies to 20000 ev). S. S. Moskalev, G. V. Muradyan, and Yu. V. Adamchuk (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). 1963. 17p.

Level parameters were identified, and power functions for Zr^{90}, Zr^{91}, Zr^{92}, Zr^{94}, and Zr^{96} were found to be 0.85 ± 0.25, 1.0 ± 0.2, 1.2 ± 0.4, 1.1 ± 0.3, and 0.9 ± 0.25, respectively. The data are in agreement with optical model predictions. (R.V.J.)

6166 (NP-13367) LES SPECTRES BÊTA DE FAIBLE ENERGIE DE QUELQUES ÉLÉMENTS LOURDS (theses). (Beta Spectra of Weak Energy of Some Heavy Elements (thesis)). Jean Tousset (Lyon. Université). [1961]. 96p.

The decays of Ra^{228} and Pb^{210} are studied. Decay schemes are presented, and gamma conversion coefficients, Auger spectra, etc. are determined. Methods for source preparation are shown. (T.F.H.)

6167 (NP-13381) INVESTIGATION OF RADIATIVE PROTON CAPTURE BY ^{31}P WITH A 500 kv VAN DE GRAAFF GENERATOR (thesis). Lammert Kornelis Ter Veld (Groningen, Netherlands. Rijksuniversiteit). [1962]. 91p.

A 500-kv Van de Graaff generator is described, and production of proton beams is discussed. The use of the proton beam for analyzing the reaction $P^{31}(p,\gamma)S^{32}$ is detailed. (T.F.H.)

6168 (NP-13389) ISSLEDOVANIE GAMMA IZLUCHENIYA TSEZIYA-140. (Gamma Emission from Cesium-140). E. A. Zherebin, A. I. Krylov, V. I. Polikarpov, and N. N. Yuzvuk (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 6p.

Beta decay of Cs^{140} to Ba^{140} was analyzed, and it shows that the first energy level for Ba^{140} is at 0.59 Mev. An analysis of spins and evenness of excited even-even nuclei indicates that the first excitation levels have 2 spins and positive evenness (2^+ spin). Cameron grid extrapolation for odd-odd nuclear decay at mass 128 to 208 indicated a total decay energy for Cs^{140} of not less than 5 Mev. An analogy with Cs^{138} predicts β-decay at the 0.59-Mev level. Consequently anticipated β emission from the upper level should be not less than 4.4 Mev. Gamma spectra of Cs^{140} measured at 0.59 and between 2.5 and 3.5 Mev are given. (R.V.J.)

6169 (NP-13426) LONGITUDINAL NUCLEAR SPIN-SPIN RELAXATION. R. L. Strombotne and E. L. Hahn (California. Univ., Berkeley). [1963]. Contract AT(11-1)-34. 49p.

The nuclear magnetization that appears after a sudden unidirectional step magnetic field is applied non-adiabatically to an ordered spin system which has been prepared

by the process of adiabatic demagnetization was studied experimentally and theoretically. The magnetization exhibits damped oscillations about a non-vanishing equilibrium value. The oscillation frequencies correspond to the fundamental and harmonic components of Larmor frequency determined by the combined effect of local dipole and external step fields. The oscillations arise as the internally ordered dipole-dipole interaction energy exchanges with the suddenly imposed Zeeman energy reservoir. A density matrix calculation carried to second order in time dependent perturbation theory, combined with a gaussian decay model, accounts for the observed oscillations within times comparable to the decay time. Fluorine nuclei in single CaF_2 crystals were studied for various crystal orientations with respect to the applied step field. For long times after step field application, the attainment of thermal equilibrium between dipole-dipole and Zeeman reservoirs permits prediction, using the spin temperature concept, of magnetization developed along the step field. (auth)

6170 (NP-13439) O POGRESHNOSTYAKH V OPREDELENII POSTOYANNYKH RASPADA PRI GROFICHESKOM ANALIZE EKSPONENTSIALOV. (On the Errors in Determination of Decay Constants in Graphical Exponential Analysis). A. Filip (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). Apr. 1963. 9p.

In studying a mixture of radioisotopes in order to determine the components, the half lives or the absorption coeffieients of the radiations (exponential approximations) must be differentiated. Practically, this gives a dissociation curve which may be considered the sum of the exponentials corresponding to the simple components. The components are determined by extrapolation and from this curve on semilogarithmic coordinates, since there are errors in the determination of the points on the curve and in the analytical method because of neglect of the contribution of certain terms. Formulas were derived for evaluating the errors in determining any exponental member as a function of the statistical error of measurement of the points on the curve, of the ratios of abundance, of the different exponentials in the mixture, and the ratio of their decay constants. (TTT)

6171 (NP-13444) OB ABSOLUTNOM IZMERENII SKOROSTI RASPADA METODOM 4π β-γ SOVPADENII. (On 4π β-γ Coincidence Method for Absolute Measurements of Decay Rates). A. Filip, I. Gyrlya, V. Papuryanu, and G. Fodor (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Apr. 1963. 12p.

The most accurate method for measuring neutron flux, the activation method, depends on determinations of decay rates. Formulas are presented for determination of the absolute rate of decay of radionuclides from beta-gamma coincidence measurements, with corrections for such factors as dead time, background, and simplifying assumptions. Curves for coincidence versus resolution time were plotted, from which the real coincidence time was determined, and the results were compared with those obtained from the formulas. Since errors resulting from the use of the curves in place of the formulas may thus be estimated, the use of the formulas becomes unnecessary. In an experimental study of the variables, the values for the decay rate of a Au^{198} source determined from the curves differed from those determined from the formulas by less than 0.8%. For the experiments a 4π "pillbox" counter, with a tungsten anode of 0.05 mm diameter and methane gas, was used. The dead time was 5 μsec. (TTT)

6172 (ORNL-3499(Vol.I)(p.11-15)) MEASUREMENT OF α, THE RATIO OF THE NEUTRON CAPTURE CROSS SECTION TO FISSION CROSS SECTION, OF U^{235} AT kev NEUTRON ENERGIES. L. W. Weston, G. de Saussure, and R. Gwin (Oak Ridge National Lab., Tenn.).

The α of U^{235} for incident neutron energies from 12 to 690 kev was measured by directing a pulsed neutron beam against a U^{235} sample placed at the center of a liquid scintillator loaded with gadolinium. Capture and fission events were distinguished by characteristic gamma emissions. Neutron energies below 100 kev were determined by time-of-flight techniques. (D.C.W.)

6173 (ORNL-3499(Vol.I)(p.15-17)) AN INVESTIGATION OF THE FEASIBILITY OF MEASURING α BY UTILIZING THE DIFFERENCE IN THE TOTAL ENERGIES OF PHOTONS EMITTED IN A FISSION EVENT AND A CAPTURE EVENT. R. Gwin, G. de Saussure, L. W. Weston (Oak Ridge National Lab., Tenn.), E. Haddad, and W. M. Lopez (General Atomic Div., General Dynamics Corp., San Diego, Calif.).

The feasibility of measuring the neutron capture-to-fission ratio, α, by using the difference between the pulse height distribution resulting from the absorption of capture gamma rays in a scintillation detector and that resulting from the absorption of fission gamma rays was experimentally tested. Results for U^{235} indicate that the method should be considered for α measurements for U^{233} and Pu^{239}. (D.C.W.)

6174 (ORNL-3499(Vol.I)(p.20-3)) ELASTIC AND INELASTIC SCATTERING OF PROTONS BY THE EVEN-EVEN GERMANIUM ISOTOPES. J. K. Dickens, F. G. Perey, and R. J. Silva (Oak Ridge National Lab., Tenn.).

The angular distributions of 11-Mev protons elastically scattered by Ge^{70}, Ge^{72}, Ge^{74}, and Ge^{76} and inelastically scattered by the first 2+ excited states of these nuclei were measured. Additionally, several new levels in Ge^{70}, Ge^{74}, and Ge^{76} were observed; and the positions of the 3- collective states of the four isotopes were determined. (D.C.W.)

6175 (ORNL-3499(Vol.I)(p.24-6)) INELASTIC SCATTERING OF PROTONS FROM Cu^{63} AND Cu^{65} AND THE EXCITED-CORE MODEL. J. K. Dickens, F. G. Perey, and R. J. Silva (Oak Ridge National Lab., Tenn.).

The predictions of the excited-core model for the excitation and spins of Cu^{63} and Cu^{65} levels were tested by measuring the angular distributions for inelastic scattering of 11-Mev protons by Cu^{63}, Cu^{65}, Ni^{62}, and Ni^{64}. The results are discussed. (D.C.W.)

6176 (ORNL-3499(Vol.I)(p.27-9)) OPTICAL MODEL ANALYSIS OF 15-Mev DEUTERON ELASTIC-SCATTERING ANGULAR DISTRIBUTIONS. C. M. Perey and F. G. Perey (Oak Ridge National Lab., Tenn.).

An optical model analysis of angular distribution measurements on 23 elements was performed, and the results for Ti, Fe, Cu, Rh, Pd, Sn, Ta, Au, and Pb were compared with values previously obtained. (auth)

6177 (ORNL-3499(Vol.I)(p.29-31)) ELASTIC AND INELASTIC SCATTERING OF 5- TO 13.5-Mev DEUTERONS FROM Ni^{60}. J. K. Dickens, F. G. Perey, and R. J. Silva (Oak Ridge National Lab., Tenn.).

Differential cross sections for deuteron elastic scattering from Ni^{60} at 4.86 to 13.56 Mev were measured. The magnitude and shape of the angular distributions vary smoothly with increasing deuteron energy. Differential cross sections for deuterons inelastically scattered at 9.89 to 13.56 Mev from the first excited state at 1.332 Mev were obtained. The inelastic angular distributions exhibit definite maxima and minima and change slowly with increasing deuteron energy. (auth)

6178 (ORNL-3499(Vol.I)(p.40-1)) NOTE ON THE MEASUREMENT OF DEUTERON POLARIZATION. M. S. Bokhari (Oak Ridge National Lab., Tenn.).

It is shown that by using polarization properties of pickup and stripping reactions the deuteron scattering matrix for a spin-zero target can be determined by double- rather than triple-scattering measurements. (auth)

6179 (ORNL-3499(Vol.I)(p.42-6)) THE SPECTRA OF GAMMA RAYS RESULTING FROM THERMAL-NEUTRON CAPTURE IN ISOTOPES OF ZIRCONIUM. G. T. Chapman, J. A. Harvey, G. G. Slaughter, and J. R. Bird (Oak Ridge National Lab., Tenn.).

The gamma spectra from thermal neutron capture in Zr^{90}, Zr^{91}, Zr^{92}, Zr^{94}, and Zr^{96} were measured with the 9-in. diameter, 12-in. long NaI(Tl) crystal and its shield from the Model IV spectrometer. Evidence for two principal modes of decay from the thermal neutron-exicted Zr^{92} level was noted. The gamma spectrum from resonance neutron capture in Zr^{96} was also measured. (auth)

6180 (PAN-257) ELASTIC SCATTERING AND TOTAL REACTION CROSS SECTIONS FOR THE INTERACTION OF 12.8-Mev DEUTERONS WITH ^{12}C, ^{58}Ni, ^{60}Ni, AND ^{209}Bi NUCLEI. A. Budzanowski, L. Freindl, K. Grotowski, P. E. Hodgson, M. Rzeszutko, M. Slapa, and J. Szmider (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). July 1963. 37p.

The differential cross sections for the elastic scattering of 12.8-Mev deuterons by C^{12}, Ni^{58}, Ni^{60}, and Bi^{209} were measured, and the corresponding reaction cross-sections were determined by summing the partial reaction cross-sections. The data were analyzed using the optical model of the interaction. 40 references. (auth)

6181 (RISÖ-61) SLOW NEUTRON CROSS SECTIONS FOR He^3, B AND Au. J. Als-Nielsen and O. Dietrich (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1963. 16p. (EANDC(OR)21U)

The neutron cross section of He^3 measured for neutron energies from 0.0003 to 10 ev. In this energy region no deviation from the 1/v law was detected. The cross section at 2200 m/sec was found to be 5327 b. As an instrumental check the cross sections of natural B and of Au were also measured. The results agree with the most accurate existing data. The absorption cross sections at 2200 m/sec were found to be 759 ± 2.0 and 98.61 ± 0.18 b, respectively. (auth)

6182 (UCRL-11024) L = 2, 4 MIXING RATIOS IN Am^{243} α-DECAY AND MAGNETIC PERTURBATION EFFECTS. F. Asaro and K. Siegbahn (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1963. Contract W-7405-eng-48. 12p. (CONF-347-1).

From Proceedings of Uppsala Angular Correlation Conference, Uppsala, Sweden, May 1963.

A study was made of the attenuation coefficient of free atoms or ions determined by integral $\alpha-\gamma$ directional correlations from Am^{243} in a magnetic field. A thin source of Am^{243} was prepared on a thin backing plate and the recoil nuclei, associated with alpha particles passing through the plate, emit gamma in the vacuum. The vacuum anisotropy was studied as a function of an external magnetic field applied parallel to the alpha paths. An Ag cover foil was provided so that the recoils would strike it after $\sim 1.5 \times 10^{-10}$ sec in the vacuum and it was shown that vacuum perturbation of the correlation takes place in less than that time. The correlation between alpha of 118 and 75 kev was measured with the recoils in an Ag environment. (R.E.U.)

6183 (UCRL-11049) THE ISOMER RATIO OF $Ce^{137m}-Ce^{137g}$ PRODUCED IN SEVERAL CHARGED-PARTICLE REACTIONS (thesis). Richard Leslie Kiefer (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 17, 1963. Contract W-7405-eng-48. 89p.

The isomer ratio Ce^{137m}/Ce^{137g} was studied to obtain information on the effect of angular momentum in the de-excitation of a compound nucleus. The ratio of the formation cross section of the high-spin isomer to that of the low-spin isomer was measured as a function of energy for reactions induced by He^3, He^4, Li^7, and C^{12}. The ratio increases with increasing projectile energy, and increase corresponds to an increase in the average angular momentum. The ratio at the peak of the excitation function increases linearly from reaction to reaction with increasing (ℓ). Above the peak of the excitation function, the ratio increases more rapidly. This is attributed to the competition of neutron and γ-ray emission that causes the product to be formed from states of high angular momentum. The cross sections for the four reactions were also measured. Those induced by Li^7 and C^{12} peak 5 to 6 Mev above the cross sections induced by He^3 and He^4. The results are compared with calculations based on the Huizenga-Vandenbosch theory. When we calculated the nuclear temperature based on the Fermi gas model and used 0.7 of the rigid-body value of the moment of inertia, the calculated results showed good agreement with the experimental results. Calculations employing a simple pairing model and a superconductor model are also shown. 57 references. (auth)

6184 (SC-T-523) NEUTRON SHIELDING OF METALS IN THERMAL NEUTRON ACTIVATION. Yuichiro Kamemoto and Yoshihiro Onoda. Translated by Shyoko Hiraga (Sandia Corp., Albuquerque, N. Mex.), from Nippon Kagaku Zasshi, 83: 1164-7(1962). 12p.

The experiment was performed in order to obtain the relation between the neutron absorption cross section and the amount of sample in which neutron shielding starts to appear. Neutron irradiation was performed on samples simultaneously in an atomic furnace. After irradiation the samples were dissolved, then the variation of specific radioactivities according to the size of samples was examined from the radioactivities of these solutions. The mass of samples, Mg, in which specific radioactivity makes a 10% decrease in comparison to the value of the mass 0 was obtained on the figure. Mg was considered to be the size of samples in which the effect of neutron shielding appears. As a result of the experiments with metallic chunk samples it was found that the following general relationship exists between Mg and the neutron absorption cross section (N barn) of elements. (N × M/atomic wt. of sample = 0.02 ~ 0.04). Using gold as the monitor, the homogeneity of thermal neutron lattice within capsules was examined. The capsule in which 7 gold samples were placed at various points was irradiated by experimental hole No. 16 of JRR-1 atomic furnace. After the irradiation the specific radioactivity of each sample was obtained and it was found that the deviations were within ±2%. This result shows that the homogeneity of neutron lattice within the capsule is in a satisfactory state. (auth)

6185 (SC-T-526) EFFECT OF THERMAL DEFORMATIONS OF A BLOCH SHELL ON THE NUCLEAR RESONANCE IN THE SHELL. J. Seiden. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Compt. Rend., 254: 1774-6(1962). 5p.

Previously it was shown that as long as the dimension

R of the ferromagnetic particle remains smaller than a certain length R_0, only the fundamental mode of deformation in the shell contributes appreciably to the spin lattice relaxation. Contributions of various modes are considered; and relations for the longitudinal relaxation time and the difference between the frequencies of the nuclear resonance at a point and at the shell boundary and the domain are derived for $R >$ and $< R_0$. (D.C.W.)

6186 STRONG ABSORPTION MODEL FOR ELASTIC NUCLEAR SCATTERING. PART II. R. H. Venter (Univ. of Stellenbosch, South Africa). Ann. Phys. (N. Y.), 25: 405-23(Dec. 1963).

A consistent approximation procedure is developed for the analytical treatment of elastic scattering of neutral and charged particles by complex nuclei in the presence of strong absorption. (auth)

6187 ABSOLUTE ACTIVITY DETERMINATION OF ELECTRON CAPTURE RADIATION WITH AN OVERPRESSURE PROPORTIONAL COUNTER. Klaus Friedrich (Institut für Angewandte Radioaktivität, Leipzig). Atomkernenergie, 8: 400-4(Nov. 1963). (In German)

A measuring arrangement for the absolute activity determination of Fe^{55} and Mn^{54} preparation is described. In a proportional counter, operated with overpressure, the x-ray quanta of the K-shell are counted. After making corrections for the carrier foil absorption, preparation carrier screening, and gamma sensitivity, the absolute x-ray emission can be stated. The activity is calculated by using the fluorescence yield, taken from statements made in literature, and the L/K ratio. (auth)

6188 DETERMINATION OF THE SPIN OF THE GROUND LEVEL OF Hg^{203} BY MEASUREMENT OF THE TRANSVERSAL POLARIZATION OF THE K-CONVERSION ELECTRONS FOLLOWING β DECAY. H.-R. Naumann and H. Schneider (Justus-Liebig-Universität, Giessen, Ger.). Atomkernenergie, 8: 406-10(Nov. 1963). (In German)

The polarization of K-conversion electrons which follow the β decay of Hg^{203} was measured by determining the right-left asymmetry in Mott scattering on a thin gold foil. The result of the polarization, $P^eK = (-0.42 \pm 0.18)$ v/c, indicates a spin sequence $5/2-3/2-1/2$ in the decay of Hg^{203} to Tl^{203}. (auth)

6189 OBSERVATION OF DELAYED PROTON RADIOACTIVITY. R. Barton, R. McPherson, R. E. Bell, W. R. Frisken, W. T. Link, and R. B. Moore (McGill Univ., Montreal). Can. J. Phys., 41: 2007-25(Dec. 1963).

The observation of delayed proton emission is reported. Bombardment of both aluminum and silicon with 97-Mev protons leads to the emission of delayed proton energy groups from 2 to 5 Mev. They follow the beta decay of Si^{25} to proton-unstable excited states of Al^{25}. Delayed protons were also observed following bombardment of Mg, Na, F, N, and O. The energy groups in the delayed proton spectra are explained. The observed delayed proton energies are those deduced by assuming that known levels of the intermediate nucleus emit the protons. Agreement of this kind, together with cross bombardment, threshold, and lifetime measurements, established the observation of the previously unreported Si^{25}. With less experimental detail, delayed protons were assigned to the decay schemes of the previously unreported Mg^{21}, Ne^{17}, and O^{13}. (auth)

6190 SPIN-ORBIT SPLITTING AMONG CERTAIN LIGHT NUCLEI DUE TO THE TWO-BODY SPIN-ORBIT POTENTIAL. P. D. Kunz (Univ. of Colorado, Boulder). Can. J. Phys., 41: 2187-2201(Dec. 1963).

The separation of doublet levels in the mass 5, 6, 14, and 17 systems is calculated from recent semiphenomenological potentials. Shell-model harmonic-oscillator functions are used to represent the nucleons. These wave functions are modified by means of correlation functions that vanish whenever any two nucleons approach closer than the hard-core radius and approach the unmodified oscillator function for large nucleon separations. It is found that the two-body spin-orbit potentials give 50 to 70% of the experimentally observed splittings. (auth)

6191 STRUCTURE OF THORIUM A-LINE. G. T. Ewan (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 41: 2202-5(Dec. 1963). (AECL-1865)

The shape of the Th A-line (L_1 39.85 kev) was studied at high resolution in a β-ray spectrometer. The broadening of the line is found to be due to two effects: the nuclear recoil due to the α decay preceding the 39.85-kev transition, and the presence of the K-conversion line of a 115.1-kev transition in Bi^{212}. The relative intensities of the K 115.1-kev line and the L_1 39.85-kev line are (0.195 ± 0.02): 1. The energy separation is 142 ± 8 ev. (auth)

6192 DETERMINATION OF THE RATIO OF THE NUCLEAR MAGNETIC MOMENTS OF Hg^{199} AND Hg^{201}. Jean-Claude Lehmann and René Barbé (l'École Normale Supérieure, Paris). Compt. Rend., 257: 3152-4(Nov. 18, 1963). (In French)

The method of optical detection of the magnetic resonance, utilizing the modulation of the absorption of a beam at a right angle to the static magnetic field, is used to determine the ratio of the nuclear magnetic moments of Hg^{199} and Hg^{201}. (tr-auth)

6193 LIFETIME STUDIES IN TELLURIUM-121. M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Current Sci. (India), 32: 159(Apr. 1963).

By delayed coincidence measurements, an upper limit of one nanosec was determined for the lifetime of the 214-kev level in Te^{121}. A Te^{121} source (half life = 154 days) was produced by (p,n) reaction on natural Sb. Delayed coincidences were measured between the K x ray following the internal conversion of the 82-kev transition and the succeeding 214-kev γ ray. For the prompt coincidence curve the coincidences between K x ray and 160-kev γ ray, following the decay of 104-day Te^{123} (which was simultaneously produced along with Te^{121}), were used. The 160-kev level is known to have a half life of 1.9×10^{-10} sec of delayed coincidence measurements, compared with the observed upper limit of one nanosec for the 214-kev level in Te^{121}. This lifetime upper limit yields an upper limit of 400 for the M 1 retardation factor, which is not small enough to rule out the l-forbidden assignment. l-forbidden M-1 transitions are known to be retarded by factors of 30 to 900 compared to single particle estimates. The internal conversion coefficient for the 214-kev transition in Te^{121} leads to M-1 assignment. The ground state of Te^{121} is known to be one-half. In this region there are available $s_{1/2}$ and $d_{1/2}$ single particle orbitals. The M-1 assignment for the 214-kev transition is consistent with the assumption that these configurations describe the ground state and first excited state respectively, with the condition, however, that the transition should be l-forbidden ($\Delta l = 2$) and consequently slower than the single particle speeds. (BBB)

6194 ON RADIATIVE μ-CAPTURE IN NUCLEI. F. Janouch and M. Vinduska (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 13: 710-15(1963). (In Russian)

The radiative μ-capture from the K-orbit of complex

nuclei is investigated for an allowed transition. The probability and circular polarization degree are calculated. (auth)

6195 ON NUCLEAR RELAXATION IN BLOCH WALLS. E. Šimánek (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 13: 732-6(1963).

The influence of the non-linear rotation of the vector of local magnetization of a Bloch wall on the nuclear spin-lattice relaxation, given by the thermal fluctuations of the wall, is studied. On the basis of a model of uniform mode the fluctuations of the transversal hyperfine field, proportional to the square of the wall displacement, are included in the calculation of the relaxation rate. Compared with the linear process, this quadratic effect plays a role in very small particles having thin walls with a small damping coefficient and for a low frequency of the nuclear magnetic resonance. Orientational estimates of the relaxation rate are made for nuclear magnetic resonance in small particles of nickel. (auth)

6196 ELASTIC SCATTERING OF 9-Mev GAMMA QUANTA ON LEAD AND URANIUM. R. Boesch, J. Lang, R. Mueller, and W. Woelfli (Technische Hochschule, Zürich). Helv. Phys. Acta, 36: 625-56(1963). (In German)

Theoretical and experimental results on the elastic scattering of gamma rays (nuclear Thomson, Rayleigh, Delbrück, and nuclear resonance scattering) were collected, and experimental investigations, using the Ni(n,γ) reaction to produce 9-Mev γ radiation at a reactor in order to measure differential cross sections for lead and uranium at angles between 20 and 144°, are described. The results agree with the theoretical predictions at large angles; at small angles only if the Delbrück scattering is taken into consideration. The studies therefore provide evidence of γ elastic scattering by nuclear electromagnetic fields. (auth)

6197 INVESTIGATION OF THE NUCLEAR PHOTOEFFECT ON Be^9 AND H^2 WITH DISCRETE GAMMA ENERGIES BETWEEN 2.75 AND 9.0 Mev. R. Boesch, J. Lang, R. Mueller, and W. Woelfli (Eidgenössische Teche Hochschule, Zürich). Helv. Phys. Acta, 36: 637-92(1963). (In German)

The photodisintegration of Be^9 and H^2 was studied by measuring the polarization of photoneutrons at 2.75 Mev with a 500-C Na^{24}-source, and also by determining the angular distribution and total cross section in the range from 5.4 to 9.0 Mev using four (n,γ) spectra as gamma sources. With these energies, the photoneutrons for Be^9 as recorded using a liquid scintillator with pulse-shape discrimination, indicated the existence of two neutron groups, which correspond, respectively, to the reactions $Be^9(\gamma,n)Be^{8}$ and $Be^9(\gamma,n)Be^{8*}$ or $Be^9(\gamma,\alpha)He^5 \rightarrow He^4 + n$. The ratio between the cross section for the transition to the ground state of Be^8 and the total cross section is 50% at 5.4 Mev and approximately 30% between 6 and 9 Mev. The angular distribution given by the form $d\sigma/d\Omega = a + b \sin^2\Theta$, with ratio a/b = 3.68 to 5.05 thus but weakly dependent upon energy, suggests an E1-transition to the $D_{\frac{3}{2}}$ final state. The angular distribution of the H^2 photoneutrons is of the form $d\sigma/d\Omega = a + b \sin^2\Theta\,(1 - \beta\cos\Theta)$ with good agreement between experimental and theoretical values of the parameters within experimental error limits. Long counters were used for the determination of the cross section and for the polarization studies. The measured polarizations of photoneutrons from H^2 for the reaction angles Θ_{cm} = 44.4 and 93.6° are, respectively, 33 and 20%, in good agreement with theory. However, contrary to the predictions of the single-particle model of Guth and Mullin no polarization of the photoneutrons from Be^9 was detected. (auth)

6198 REACTION $N^{14}(d,n)O^{15*}$ (5,20; 5,25 AND 6,15 Mev). W. R. Gibbs and W. E. Grueebler (Université, Neuchâtel, Switzerland). Helv. Phys. Acta, 36: 693-8(1963).

The extent to which the Distorted Wave Born Approximation theory (DWBA) can explain the shape of the angular distribution and particularly the backward peaking in the reaction $N^{14}(d,n)O^{15}$ was investigated. Neutron spectra and angular distributions are shown in graphs. The DWBA calculations showed that the simple Butler theory is not able to explain the detailed features of the angular distribution. Results on the doublet state threw doubt on the presence of heavy-particle stripping and showed that it is possible to explain the largest part of the backward peaking purely as distortion effects and contributions from stripping taking place in the interior of the nucleus. (M.C.G.)

6199 ANGULAR CORRELATION $(n' - \gamma)$ FOR $Fe^{56}(n,n'\gamma)_{0.845}$ AT 2.0 Mev. Tomasz Niewodniczański and Max P. Steiger (Eidgenössische Technische Hochschule, Zürich). Helv. Phys. Acta, 36: 707-38(1963). (In German)

The angular correlation between inelastically scattered neutrons and gamma rays from the first excited state was measured for the reaction $Fe^{56}(n,n'\gamma)_{0.845}$. In order to avoid the excitation of the 2.085-Mev state, the energy of the incident neutrons was limited to $(2.06 \pm 0.10)\ Mev_{lab}$. The experiment was undertaken with ring geometry using a fast-slow coincidence circuit having a time resolution 2τ = 12 ns. Altogether, 56 angle pairs were measured as a basic test of symmetries inherent in the compound nucleus theory. The slight asymmetry displayed by the experimental results indicated possible competition of the direct interaction mechanism. (auth)

6200 (p,n) THRESHOLD MEASUREMENTS ON Na, Al, Cu, Ga, Ge, Se, Y, AND Sn. Kotoyuki Okano and Kazuaki Nishimura (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 18: 1563-8(Nov. 1963).

Q-values were measured for (p,n) reactions on Na^{23}, Al^{27}, Cu^{63}, Cu^{65}, Ga^{69}, Ge^{74}, Se^{77}, Se^{78}, Se^{80}, Y^{89}, Sn^{118}, and Sn^{120} by detecting slow neutrons associated with the thresholds. Using the well-established threshold energies of (p,n) reactions on Li^7, C^{13}, and F^{19} as calibration standards, the following Q-values in kev were obtained: $Na^{23}(p,n)Mg^{23}$, -4843.2 ± 5.1; $Al^{27}(p,n)Si^{27}$, -5597.5 ± 60; $Cu^{63}(p,n)Zn^{63}$, -4150.0 ± 4.4; $Cu^{65}(p,n)Zn^{65}$, -2135.3 ± 1.8; $Ga^{69}(p,n)Ge^{69}$, -3008.8 ± 3.2; $Ge^{74}(p,n)As^{74}$, -3343.5 ± 5.6; $Se^{77}(p,n)Br^{77}$, -2147.0 ± 3.9; $Se^{78}(p,n)Br^{78}$, -4355 ± 7.4; $Se^{80}(p,n)Br^{80}$, -2655.2 ± 2.8; $Y^{89}(p,n)Zr^{89}$, -3613.7 ± 4.1; $Y^{89}(p,n)Zr^{89m}$, -4199.8 ± 4.1; $Sn^{118}(p,n)Sb^{118}$, -4477.8 ± 5.7; and $Sn^{120}(p,n)Sb^{120}$, -3462.9 ± 7.1. These results are compared with the previously reported Q-values. (auth)

6201 $Al^{27}(\gamma,\pi^+)Mg^{27}$ AND $Al^{27} \rightarrow Na^{24}$ REACTIONS INDUCED BY HIGH ENERGY γ-RAYS. Akira Masaike (Kyoto Univ.), Yoshio Yoshimura, Yojirō Murata, Asao Kusumegi, and Kunio Takamatsu. J. Phys. Soc. Japan, 18: 1692(Nov. 1963).

Residual activities from the high-energy photonuclear reactions were studied above the meson threshold energy to get some information on the effect of the $(\frac{3}{2}, \frac{3}{2})$ resonance state of a nucleon on nuclear reactions and about the process accompanying it with the emission of a single π meson only. (R.E.U.)

6202 EXCITATION OF INDIVIDUAL FISSION FRAGMENTS AT SCISSION. Takao Honda (Univ. of Yamanashi, Kofu, Japan). J. Phys. Soc. Japan, 18: 1697(Nov. 1963).

A model is proposed for fission fragments at scission with spheroidal shape and contact at acute points. A saw-tooth dependency of excitation of individual fragments on

their masses is desired and can be reproduced from this model. (R.E.U.)

6203 INTERNAL MODERATING RADIATION IN ELECTRON CAPTURE. Denes Berenyi (Nuclear Research Inst., Hungarian Academy of Sciences, Debrecen). Magy. Fiz. Folyoirat, 11: 295-303(1963).

Recent literature pertaining to internal moderating radiation in electron capture was reviewed. Fifty-nine references (including 2 German, 4 Russian, and 53 Western) were cited. (OTS)

6204 RADIOACTIVE DECAY OF ANTIMONY-124. A. Seshagiri Rao, V. Lakshminarayana, and Swami Jnanananda (Andhra Univ., Waltair, India). Nature, 200: 750-1 (Nov. 23, 1963).

The decay of Sb^{124} was examined with a fast-slow type of Compton scintillation spectrometer. Although the work supports the existence of new lines at 1900 and 2260 kev, it was not possible to fix their positions in the level diagram based on the results. Most of the lines occurring in the decay of Sb^{124} and not appearing in the singles spectrum could be recorded in the coincidence spectrum because of the Compton suppression. (P.C.H.)

6205 SODIUM-24 PRODUCED BY COSMIC RADIATION. W. Roedel (Universität, Ger.). Nature, 200: 999-1000(Dec. 7, 1963).

Na^{24} produced by cosmic radiation was detected in several rains. The 2.75-Mev gamma ray was measured using a NaI(Tl) crystal. The rain water was collected, put through an ion-exchange column, and sodium eluted with 0.67N HCl. Aluminum chloride was added to the solution and the aluminum along with all other ions except sodium were precipitated as hydroxide. The solution was evaporated to dryness and the sodium counted. The lifetime was also used to identify Na^{24}. Three samples were measured and values of 235 ± 25, 455 ± 40, and 245 ± 40 atoms/l were obtained. (M.C.G.)

6206 ANGULAR DISTRIBUTIONS FOR THE REACTION He^3 + T. Berthold Kuehn and Balint Schlenk (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 48: 353-60(Oct. 1963). (In German)

The angular distributions were measured for protons and neutrons resulting from the interaction He^3 + T at incident tritium ion energies of 460, 665, 900, and 1087 kev. The angular distributions were found to be anisotropic and energy dependent. By means of the observed distributions new values were calculated for the cross-sections of three different reaction channels and for the total He^3 + T cross-section. It is suggested that the reaction is predominantly of the compound type, proceeding through the compound system Li^6. (auth)

6207 PHOTOPROTONS FROM CARBON. H. D. Warren and A. P. Batson (Univ. of Virginia, Charlottesville). Nucl. Phys., 48: 361-8(Oct. 1963). (TID-18957)

The angular and energy distributions of photoprotons from C^{12} were measured from 6.75 to 21-Mev proton energies with an E, dE/dx coincidence-counting spectrometer and with 65-Mev maximum gamma energy. The spectrometer consisted of a CsI(Tl) crystal as the E detector and a silicon p-n junction diode as the dE/dx detector. The data were analyzed in 1-Mev intervals, and the equation for electric dipole-electric quadrupole interference in a direct interaction was fitted to the data of each energy bin by the least-squares method. The results indicate that the direct interaction model with E1-E2 interference gives a good description of the interaction, with the magnitude of the interference increasing with increasing proton energy. The energy spectra show the existence of a small resonance near 13-Mev proton energy. (auth)

6208 NUCLEAR POLARIZATION FOLLOWING PHOTOPRODUCTION OF PIONS FROM NUCLEI. [PART] I. G. Ramachandran (Inst. of Mathematical Sciences, Madras) and V. Devanathan. Nucl. Phys., 48: 369-74 (Oct. 1963).

It is shown that the polarization produced in the residual nucleus in the reaction $\gamma + Si^{29} \rightarrow \pi^- + P^{29}$ is quite a sensitive function of the quenching of the nucleon magnetic moments. The calculation is performed in impulse approximation and using the amplitudes of Chew et al., and the result is independent of the nuclear wave functions. An extension of the method to more complex problems is indicated. (auth)

6209 STATISTICAL FLUCTUATIONS OF ENERGY LEVELS: THE UNITARY ENSEMBLE. Peter B. Kahn (State Univ. of New York, Stony Brook) and Charles E. Porter. Nucl. Phys., 48: 385-407(Oct. 1963). (BNL-6994)

The next-nearest neighbor energy level spacing distribution for complex systems with non-time-reversal-invariant interactions is derived from the gaussian unitary ensemble in three dimensions and is compared to the similar result for the orthogonal ensemble. Since it was shown for other spacing distributions that low-dimensional results are within a few per cent of infinite-dimensional results in regions of significant probability, the three-dimensional results developed probably have rather wide numerical validity. (auth)

6210 TOTAL CROSS SECTIONS OF Na, Mg, AND Si FOR 2.8-5.2 Mev NEUTRONS. G. Calvi, R. Rocamo, A. Rubbino, and D. Zubke (Università Catania, Italy). Nucl. Phys., 48: 408-16(Oct. 1963).

The total neutron cross sections of Na, Mg, and Si were measured by the transmission method from 2.8 to 5.2 Mev. The energy spread in the whole energy range was about ±20 kev. The fluctuations of σ_T, observed in Na, Mg, Al, Si, P, and S were interpreted as being due to fluctuations of the level density of the intermediate nucleus. (auth)

6211 NUCLEAR OPTICAL MODEL AND BOUND STATES. V. Kaminskii (Moscow State Univ.), Yu. Orlov, N. Marchenko, and Yu. Orevkov. Nucl. Phys., 48: 417-21 (Oct. 1963).

By a direct numerical calculation of the partial phases of scattering of neutrons on C^{12} and O^{16} it is shown by means of the optical model for the energy interval of 0 to 200 Mev that the Levinson theorem $\delta(0) - \delta(\infty) = n\pi$, where $\delta(E)$ is a scattering phase and n is the number of bound states with a given total angular momentum and parity, proves also valid for a complex potential varying smoothly with energy, n being the number of one-particle bound states. The level schemes of C^{13} and O^{17} from the survey of Ajzenberg-Selove and Lauritsen are used in the analysis. (auth)

6212 THE LEVEL STRUCTURE OF Re^{187}. W. Michaelis (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., 48: 422-32(Oct. 1963).

The transitions and levels of Re^{187} populated by W^{187} beta decay were investigated by using prompt and delayed gamma-gamma coincidence techniques. The relative intensities of the gamma rays are given. The experimental reduced transition probabilities are compared with the theoretical predictions of the unified model. (auth)

6213 PROMPT NEUTRONS FROM FISSION. J. C. Hopkins and B. C. Diven (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., 48: 433-42(Oct. 1963). (LADC-5578)

An absolute measurement of ν, the average number of neutrons emitted per fission, was made for the spontaneous fission of Cf^{252}. This number is 3.771 ± 0.031 prompt neutrons per fission. Measurements of $\bar{\nu}$ for the spontaneous fission of Pu^{240} and for neutron induced fission of U^{233}, U^{235}, and Pu^{239} were made relative to the spontaneous fission $\bar{\nu}$ of Cf^{252}. Several incident neutron energies between zero and 14.5 Mev were used. A universal $\bar{\nu}$ versus incident neutron energy curve for U^{233}, U^{235}, and Pu^{239} was constructed by adding a constant energy to the incident neutron energy for each nucleide. The constants for U^{233}, U^{235}, and Pu^{239} were 0.46, 0, and 3.3 Mev, respectively. The data can be fitted with two straight lines of slopes 0.085 neutrons per Mev up to about 1.6 Mev and 0.16 neutrons per Mev above 1.6 Mev. At thermal energy the $\bar{\nu}$ value is 2.412 prompt neutrons per fission. (auth)

6214 NEUTRON CAPTURE GAMMA RAYS OF F^{20}. E. G. Nadjakov (Univ. of Tech., Göteborg). Nucl. Phys., 48: 492-9(Oct. 1963).

The spectrum of gamma rays following pile-neutron capture in fluorine was measured with a three crystal pair spectrometer. New gamma rays are reported. The decay scheme of F^{20} is tentatively extended and the properties of some levels involved are discussed. (auth)

6215 A MODEL OF VIBRATIONAL EVEN NUCLEI. N. MacDonald (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 48: 500-11(Oct. 1963).

The calculations of Raz, in a model of two particles coupled to harmonic surface vibrations, are corrected and extended. Attention is confined mainly to cases in which the second 2^+ state lies at more than twice the energy of the first 2^+ state, as in many nuclei in which both these states were studied by Coulomb excitation. It is found that the 3-phonon and 4-phonon approximations give rather similar results. In the 3-phonon approximation the results are not radically altered by changing the type of two-particle force assumed, nor are they sensitive to the angular momentum j of the single-particle states, so long as $j \geq 5/2$. For two particles with $j = 3/2$ there is a degenerate 2^+, 4^+ pair of states, and no cross-over transition from the ground state to the 2^+ member of this pair. The effect of increasing j is to separate these two states and to allow an appreciable cross-over transition probability, which is rather sensitive to the strength of the two-particle force. The model has a certain degree of success in fitting transition probabilities between low-lying states. However the first 4^+ state occurs in general below the second 2^+ state, in disagreement with experiment. Further the first 0^+ excited state lies rather high, while there is experimental evidence for such a state near or even below the second 2^+ state. (auth)

6216 POLARIZATION OF PARTICLES WITH ARBITRARY SPIN IN NUCLEAR REACTIONS. E. V. Inopin (U.A.R. Atomic Energy Establishment, Cairo). Nucl. Phys., 48: 517-18(Oct. 1963).

The problem of the number of independent parameters characterizing the spin state of a particle with an arbitrary spin is considered. The particle appears in the reaction $a + b \rightarrow c + d$ when the initial particles are not polarized. It is shown that this number is $2I(I + 1)$ if the spin is an integer and $2I(I + 1) - 1/2$ in case the spin is a half-integer. (auth)

6217 THE DECAYS OF Pm^{143}, Pm^{144} AND Pm^{146}. I. M. H. Pagden, R. Jakeways, and F. C. Flack (Univ. of Exeter, Devon, Eng.). Nucl. Phys., 48: 555-60(Nov. 1963).

Measurements are described that confirm and enlarge earlier results on the decays of the isotopes Pm^{143}, Pm^{144}, and Pm^{146}. The ground state half lives were found to be Pm^{143} 265 ± 10 d, Pm^{144} 377 ± 16 d, and Pm^{146} 1600 ± 80 d. An additional period of about 60 d was discovered in the Pm^{144} source. Attempts to detect half lives of some excited states revealed that these were less than 2×10^{-10} sec. (auth)

6218 LIFETIMES IN Sn^{120}, Ba^{138} AND Ce^{140}. W. M. Currie (Univ. of Glasgow). Nucl. Phys., 48: 561-8(Nov. 1963).

The mean lives of two states in Sn^{120} and Ba^{138} were measured by time-to-pulse-height conversion. The value found for the 2.3-Mev level in Sn^{120} is 8.24 ± 0.23 nsec, which is in good agreement with two other recent measurements. For the 1.89-Mev level in Ba^{138} the figure obtained is 3.13 ± 0.11 nsec, 8 times longer than the single-particle estimate. The slowness of the transitions in Ce^{140} and Ba^{138} is accounted for by treating them as quasi-particle transitions and using data from the work of Kisslinger and Sorensen on the theory of pairing correlations. A simple view of these quasi-particle transitions is given. (auth)

6219 ANALYSIS OF THE $Li^6(d,\alpha)He^4$ REACTION. M. El-Nadi, A. Rabie, and H. Sherif (Atomic Energy Establishment, Cairo). Nucl. Phys., 48: 569-77(Nov. 1963).

Experimental data on the $Li^6(d,\alpha)He^4$ reaction are analyzed theoretically on the basis of the two-body model and the shell model for Li^6. Both models were found to give satisfactory agreement. (auth)

6220 SOME PROPERTIES OF ODD-MASS NUCLEI HAVING A $j = 3/2$ PARTICLE COUPLED TO A VIBRATING CORE. M. Harvey (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 48: 578-92(Nov. 1963).

An investigation is made into the variations with coupling strength of the properties of odd-mass nuclei described by the Bayman-Silverberg (B&S) model in which a $j = 3/2$ particle/hole is coupled by a quadrupole-quadrupole force to a quadrupole vibrating core. The B&S general results, which give the core contribution to the ground state quadrupole moments and the reduced transition probabilities B(E2) between low-lying states, are extended in these cases to include the contribution from the $j = 3/2$ particle/hole. New results for the magnetic moments and the reduced transition probabilities B(M1) between low-lying states are derived. The variations with coupling strength of all the moments and lowest transitions are shown graphically. The general results are compared with the experimental data of Cu^{63} where some inconsistencies are noted. (auth)

6221 SCATTERING OF FAST NEUTRONS FROM NATURAL Zr AND Nb. D. Reitmann (South African Atomic Energy Board, Pretoria and Argonne National Lab., Ill.), C. A. Engelbrecht, and A. B. Smith. Nucl. Phys., 48: 593-607(Nov. 1963).

Fast time-of-flight techniques were used to measure the differential cross sections for the elastic scattering of neutrons from natural Zr and Nb. The measurements were made at ≈50-kev intervals throughout the incident neutron energy range 0.3 to 1.5 Mev. The cross sections for the excitation by inelastic neutron scattering of a 0.92-Mev level in Zr and 0.74-, 0.81-, 0.96-, and 1.08-Mev levels in Nb were measured. The results of these measurements are compared with those obtained in other experiments and with optical model calculations. Tentative spin assignments for the low lying levels in Nb^{93} are made on the basis of Hauser-Feshbach calculations and shell model predictions. (auth)

6222 PAIRING AND QUADRUPOLE INTERACTIONS IN CONFIGURATIONS j^n. S. I. Drozdov (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 48: 608-21(Nov. 1963).

An attempt is made to study the development of the collective properties of nuclei by the exact diagonalization of the Hamiltonian with pairing and quadrupole interactions in the configuration of identical nucleons $j^n = (^9/_2)^4$. The energy levels and quadrupole transition probabilities are found after the calculation of two- and one-particle fractional parentage coefficients of the given configuration. The results of the calculation are compared with the predictions of the vibrational and rotational model as well as the aligned coupling scheme. (auth)

6223 THE REACTIONS $D(d,n)He^3$ AND $D(d,p)T$ AT 25.3 Mev. W. T. H. Van Oers and K. W. Brockman, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 48: 625-46(Nov. 1963).

The differential cross sections of the mirror reactions $D(d,n)He^3$ and $D(d,p)T$ were measured at 25.3 ± 0.3 Mev incident deuteron energy. The angular distributions of the two reactions are practically identical except possibly at very small angles. The $D(d,n)He^3$ cross section was fitted using the Butler Born-approximation stripping theory. This reaction was considered in terms of a general rearrangement collision formalism. A Legendre polynomial expansion of the reaction amplitudes was found, in which higher order expansion coefficients are obtained in the Born approximation while the lower order coefficients are treated as free parameters determined by fitting the experimental cross section. (auth)

6224 LEVEL SCHEME OF Ba^{134}. S. O. Schriber and B. G. Hogg (Univ. of Manitoba, Winnipeg). Nucl. Phys., 48: 647-51(Nov. 1963).

The gamma cascades following the decay of Cs^{134} were examined using a sum coincidence spectrometer. Compton summing peaks were subtracted. No evidence for the existence of levels at 1846, 1773, and 1579 kev was found. (auth)

6225 NON-MESIC DECAY OF HYPERNUCLEI. B. Bhowmik, D. P. Goyal, and N. K. Yamdagni (Univ. of Delhi). Nucl. Phys., 48: 652-74(Nov. 1963).

A systematic study of hypernuclei, produced by K^- and Σ^- interactions in nuclear emulsion, and decaying in the non-mesic mode, is reported. The contaminations from the various background phenomena were estimated and the sample is found to be reasonably pure. From the energy distribution of the decay products, a clear separation between the proton-stimulated and neutron-stimulated events was obtained. The ratios of the proton to neutron stimulated decays for He-hyperfragments and for hyperfragments with charge ≧3 are determined as 3.8 and 2.5, respectively. These values are clearly greater than unity, and according to Ferrari and Fonda's calculations, therefore, indicate that the stimulation process occurs predominantly when the hyperon is in the Λ-state. A model of the stimulation process is proposed. The non-mesic/mesic ratio Q as a function of the hyperfragment-charge is determined. The weighted mean $\overline{Q}$ ($_\Lambda$He) of the various emulsion works is obtained as 1.48 ± 0.23. From this, the ratio $|p|/|s|$ of the p and s channel amplitudes in Λ-decay is estimated to be $0.20^{+0.04}_{-0.05}$. (auth)

6226 NUCLEAR SPECTROSCOPY OF ^{173}Tm. T. Kuroyanagi and T. Tamura (Japan Atomic Energy Research Inst., Tokyo). Nucl. Phys., 48: 675-85(Nov. 1963).

The Tm^{173} nuclide was produced by the (γ,p) reaction by using an intense bremsstrahlung from a linear electron accelerator. A Yb^{174} target enriched to 99% was used. The radiations from Tm^{173} were measured by means of a beta- and gamma-scintillation spectrometer. Two beta-ray groups with end-point energies of 1.26 and 0.86 Mev were found, and K x-ray, 395 and 460 kev gamma rays were observed. The excited states at 395 and 460 kev in Yb^{173} were identified as $^1/_2^+$ [651] and $^1/_2^-$ [521] intrinsic states, respectively. It was found that the 395-kev state is an isomeric level with a half life of 2.9 μsec. The assignments were made with the aid of electron–K x-ray and electron–beta coincidence methods. (auth)

6227 THE $P^{31}(n,\alpha)Al^{28}$ EXCITATION FUNCTION UP TO 5 Mev NEUTRON ENERGY. P. Cuzzocrea and G. Pappalardo (Università, Catania, Italy). Nucl. Phys., 48: 686-9(Nov. 1963).

The $P^{31}(n,\alpha)Al^{28}$ excitation function was measured in the neutron energy range 2.5–5 Mev, using the activation method. The experimental curve shows an oscillating behavior around the average value. In particular, the peak at E_n = 3.75 Mev seems to be correlated with that found in the $\sigma(n,p)$ and σ_T cross section curves, at the same neutron incoming energy. (auth)

6228 TWO NUCLEON STRIPPING AND THE $^{16}O(^3He,p\gamma)^{18}F$ REACTION. S. Hinds and B. M. Hinds (California Inst. of Tech., Pasadena). Nucl. Phys., 48: 690-6 (Nov. 1963).

The mechanism of the $O^{16}(He^3,p\gamma)F^{18}$ reaction proceeding via the first excited state of F^{18} at 0.934-Mev excitation was studied by measuring the angular correlation in the plane of the reaction of the de-excitation gamma rays in coincidence with the proton group leading to this state. Correlations were measured at a fixed proton angle of 36° with incident He^3 energies of 9.16 and 10.0 Mev and also at a proton angle of 71° with an incident beam energy of 10.0 Mev. With the proton counter on the peak of the stripping curve at 36°, an axis of symmetry was found about 26° from the direction of the recoiling F^{18} nucleus. The correlations are analyzed and discussed and are presented as favoring the two nucleon stripping process, where the two nucleons are captured as a lump, as being the predominant reaction mechanism for the $O^{16}(He^3,p)F^{18}$ reaction at a bombarding energy of about 10 Mev. (auth)

6229 PROBLEMS OF THE OPTICAL MODEL FOR DEUTERONS. II. EXPERIMENTS FOR DETERMINATION OF THE PARAMETERS OF THE OPTICAL POTENTIAL FOR DEUTERONS. Kazimierz Grotowski (Inst. of Nuclear Physics, Polish Academy of Sciences, Krakow). Nukleonika, 8: 355-69(1963). (In Polish)

An experiment for determination of the parameters of the optical potential for deuterons is presented. Total reaction cross sections for the interaction of deuterons with nuclei were determined by evaluating the cross sections for the emission of charged particles and neutrons. The angular distributions for the elastic scattering of deuterons were also measured. (auth)

6230 PROBLEMS OF THE ELASTIC SCATTERING OF DEUTERONS ON ATOMIC NUCLEI. II. POLARIZATION IN ELASTIC SCATTERING OF DEUTERONS. Adam Strzalkowski (Inst. of Nuclear Physics, Polish Academy of Sciences, Krakow). Nukleonika, 8: 371-84(1963). (In Polish)

The formalism for the description of scattering of the spin-one particles is given. The results of measurements of polarization in elastic scattering of deuterons on atomic nuclei and experiments on nuclear reactions with polarized deuterons are discussed. (auth)

6231 EFFECTIVE PROTON-NEUTRON INTERACTION FOR $50 \leq A \leq 58$. J. Vervier (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Phys. Letters, 7: 200-2 (Nov. 15, 1963).

It is shown that a large number of experimental data on the ground state binding energies, spins, and magnetic moments of nuclei with $20 \leq Z \leq 28$ and $N = 29$ and 30 can satisfactorily be accounted for by assuming that the protons and neutrons outside the closed shells $Z = 20$ and $N = 28$ are in $f_{\frac{7}{2}}$ and $p_{\frac{3}{2}}$ orbits, respectively, with effective gyromagnetic ratios $g_f = 1.442$ and $g_p = -0.943$ and an effective short-range proton-neutron interaction whose strength and spin contribution are 0.726 Mev and 0.083, respectively. (C.E.S.)

6232 EXCITED STATES OF Pm^{147}. E. Spring (Univ. of Helsinki). Phys. Letters, 7: 218-19(Nov. 15, 1963).

Gamma spectra and gamma-gamma coincidences resulting from Nd^{147} β decay were investigated, and spin assignments and relative intensities of Pm^{147} excited states were ootained by means of angular correlation measurements. (C.E.S.)

6233 SPIN-EXCHANGE CROSS SECTION FOR Rb^{85}–Rb^{87} COLLISIONS. S. M. Jarrett (Univ. of Michigan, Ann Arbor). Phys. Rev., 133: A111-17(Jan. 6, 1964).

The spin-exchange cross section for Rb^{85}–Rb^{87} collisions was measured to be $(1.70 \pm 0.21) \times 10^{-14}$ cm^2 using the techniques of optical pumping and an interferometric method for measuring the Rb vapor density. The Rb^{87} constituent in a vapor of natural Rb was polarized through absorption of circularly polarized resonance radiation, and the Rb^{87} polarization was partially transferred to the Rb^{85} constituent through spin-exchange collisions. A phenomenological theory of the optical pumping plus the exchange polarization process that neglects nuclear spin was used to relate the cross section to the ratio of the signal strengths for the Rb^{87} and Rb^{85} Zeeman resonances, the relaxation time, and the Rb^{87} vapor density. The density was measured by comparing spectral profiles of the resonance radiation transmitted through the optical pumping cell at room temperature with the resonance radiation transmitted at the temperature at which the signal strengths were measured. These spectral profiles were obtained through use of a scanning Fabry-Perot interferometer. (auth)

6234 ANOTHER SEARCH FOR H^5. A. Schwarzschild, A. M. Poskanzer, G. T. Emery, and M. Goldhaber (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B1-2 (Jan. 13, 1964).

An attempt was made to produce the 110-msec energetic electron activity recently reported to result from photon irradiation of lithium. The activity was not found in the high-energy proton bombardment of lithium, and the production cross section is $< 5 \times 10^{-4}$ times that for producing Li^9 from boron under the same conditions. This indicates that the high-energy proton activation cross section of lithium for such an activity is ≤ 1 μb. (auth)

6235 THEORY OF FINITE-RANGE DISTORTED-WAVES CALCULATIONS. N. Austern (Univ. of Pittsburgh), R. M. Drisko, E. C. Halbert, and G. R. Satchler. Phys. Rev., 133: B3-16(Jan. 13, 1964).

Most distorted-waves direct-reaction calculations rely upon a zero-range approximation. The errors caused by this approximation are discussed, and a general method suitable for numerical computation is described that does not use this approximation. Applications to stripping and knock-on reactions are described in detail. (auth)

6236 ENERGY LEVELS IN Sm^{148} AND Sm^{150}. Robert A. Kenefick and Raymond K. Sheline (Florida State Univ., Tallahassee). Phys. Rev., 133: B25-34(Jan. 13, 1964).

Energy levels in Sm^{148} and Sm^{150} were observed via the reactions $Sm^{147}(d,p)Sm^{148}$, $Sm^{149}(d,p)Sm^{150}$, $Sm^{148}(p,p')Sm^{148}$, and $Sm^{150}(p,p')Sm^{150}$ at 12-Mev bombarding energy. Reaction products were analyzed in a 0.1% energy resolution magnetic spectrograph using emulsion techniques. Levels below 1.9-Mev excitation are found to have much smaller (d,p) cross sections than those above this energy. Many previously unknown levels above 1-Mev excitation were found in both these nuclei. The observed levels are compared with previous studies of these nuclei. Several of the positive parity levels in Sm^{148} can be fitted to an asymmetric rotor-vibrator spectrum. The excited states in Sm^{150} can be approximated, but not fitted exactly, with this model. The observed low-lying states in these nuclei are discussed in terms of expected level structure for collective models. The ground-state Q values for the reactions $Sm^{147}(d,p)Sm^{148}$ and $Sm^{149}(d,p)Sm^{150}$ are determined to be 5920 ± 10 and 5764 ± 4 kev, respectively. (auth)

6237 SIGN OF THE INTERFERENCE PARTICLE PARAMETER IN CONVERSION-ELECTRON DIRECTIONAL CORRELATION. E. L. Church (Frankford Arsenal, Philadelphia), A. Schwarzschild, and J. Weneser. Phys. Rev., 133: B35-41(Jan. 13, 1964). (BNL-7231)

It is shown that the interference particle parameter, $b_\nu(ML,EL')$, appearing in the directional correlation of internal-conversion electrons, has the opposite sign from that given in the literature. It is also shown that in the high-energy limit, the directional-correlation pattern for conversion electrons is identical with that of the corresponding gamma rays. (auth)

6238 DETERMINATION OF THE MULTIPOLARITY OF NUCLEAR ELECTROMAGNETIC TRANSITIONS USING A MAGNETIC PAIR SPECTROMETER. E. K. Warburton, D. E. Alburger, A. Gallmann, P. Wagner, and L. F. Chase, Jr. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B42-62(Jan. 13, 1964). (BNL-7188)

An intermediate-image magnetic pair spectrometer was modified so as to respond to positron-electron internal pairs emitted at large relative angles thereby making the pair-line transmission depend sensitively on the multipolarity of electromagnetic transitions above 2 Mev. The modification consists of a specially designed spiral baffle system that selects pairs emitted within 105° azimuthal sectors on opposite sides of the axis. Measurements are made of the net yield of an internal-pair-conversion coincidence line, both in the normal spectrometer operation and with the spiral baffle installed, giving a reduction ratio $R_\omega = Y_{\text{with baffle}}/Y_{\text{without baffle}}$. Experimental ratios were determined for 14 known transitions including E0, E1, M1, E2, M2, and E3 multipoles between 3 and 7 Mev. Theoretical calculations were carried out on the spectrometer transmission, when using the baffle, for E0, E1 through E4, and M1 through M4 transitions from nonaligned nuclei over a wide energy range. These transmissions were combined with previous calculations of the transmission without the baffle in order to derive curves of $R_\omega(l)$ versus transition energy for the various multipoles. A best fit to the experimental ratios for the known multipoles was made in the calculations by adjusting slightly the values of the mean spectrometer-entrance angle and the sector angle ω of the baffle. The various ratio curves thus obtained are spaced widely enough apart to allow clear multipole assignments to be made in most cases. For mixed transitions from aligned nuclei, calculations were made of correction

factors to be applied to the experimentally determined ratios. It is shown how the correction factors can be derived from separate measurements of the angular distributions of the corresponding gamma rays. The method was applied to a number of previously unassigned transitions in Be^{10}, B^{10}, C^{14}, and N^{14} leading to new spin and parity information on certain levels in these nuclei. In particular, it is found that the Be^{10} 6.18-Mev level and the C^{14} 6.58-Mev level are both 0^+ and the N^{14} 5.10-Mev level has odd parity. (auth)

6239 DECAY CONSTANT FOR SPONTANEOUS FISSION OF U^{238}. R. L. Fleischer and P. B. Price (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 133: B63-4(Jan. 13, 1964).

Uranium impurities in minerals undergo spontaneous fission over geologic times, leaving radiation-damage trails whose number can be related to the mineral age, provided λ_F, the spontaneous-fission decay constant of U^{238}, is known. By requiring that the ages of a large number of minerals measured in this way agree with ages determined by decay of K^{40} and Rb^{87}, a value $\lambda_F = 6.9 \times 10^{-17}$ yr^{-1} was deduced. By placing a sheet of natural uranium next to a sheet of mica for 6 months and then counting tracks entering the mica from the uranium, a value $\lambda_F = 6.6 \times 10^{-17}$ yr^{-1}, in good agreement with the above value, was obtained. A weighted average of these two results gives the value $\lambda_F = (6.85 \pm 0.20) \times 10^{-17}$ yr^{-1}. (auth)

6240 COULOMB WAVE AMPLITUDES FOR L = 0 STRIPPING REACTIONS. Fernando B. Morinigo (California Inst. of Tech., Pasadena). Phys. Rev., 133: B65-7(J (Jan. 13, 1964).

A simple analytic expression is obtained for an L = 0 stripping amplitude by means of a Coulomb wave for the relative motion of the incident particles and a plane wave for the relative motion of the products. If the initial and final-bound states may be considered asymptotic, having wave functions of the form $e^{-\lambda r}/r$, the cross sections predicted have an angular dependence identical to that predicted by a plane-wave calculation. The use of a Coulomb wave for the incident relative motion modifies only the absolute magnitude of the cross section. (auth)

6241 NONLOCAL OPTICAL-MODEL ANALYSIS OF NEUTRON SCATTERING FROM NUCLEI NEAR A = 100 AT ENERGIES BELOW 1 Mev. A. J. Elwyn, R. O. Lane, A. Langsdorf, Jr., and J. E. Monahan (Argonne National Lab., Ill.). Phys. Rev., 133: B80-93(Jan. 13, 1964).

The polarization and differential cross sections for neutrons scattered from the nuclei Zr, Nb, Mo, and Cd were measured at five angles for neutron energies between 0.275 and 0.85 Mev. The results were analyzed in terms of an optical model equivalent to the nonlocal model of Perey and Buck. The analysis leads to the following conclusions: The calculations, corrected for the effects of compound elastic scattering, are consistent with most of the scattering data when a spin-orbit potential that includes both a real ($V_S \approx$ 10 Mev) and an imaginary ($W_S \approx 4$ Mev) term of the Thomas type is employed. As calculated on the basis of this model, the magnitude and shape of the P-wave neutron strength-function peak in the region near A = 100 are rather insensitive to the values chosen for the real and imaginary spin-orbit potentials—at least for $7.2 \leq V_S \leq 20$ Mev and $0 \leq W_S \leq 7.2$ Mev. Thus, on the basis of this model the possible splitting of the 3P strength function peak cannot be interpreted in terms of a spin-orbit force. (auth)

6242 INELASTIC SCATTERING OF 10.2-Mev PROTONS BY N^{14}. P. F. Donovan (Bell Telephone Labs., Inc., Murray Hill, N. J. and Brookhaven National Lab., Upton, N. Y.), J. F. Mollenauer, and E. K. Warburton. Phys. Rev., 133: B113-16(Jan. 13, 1964). (BNL-7237)

The inelastic scattering of protons from N^{14} was studied at an incident proton energy of 10.2 Mev. Proton groups were observed corresponding to all the well-established N^{14} states below 8.0 Mev. No evidence was obtained for the levels at 7.60, 7.40, 6.60, and 6.05 Mev that were previously reported in this reaction. Angular distributions and total cross sections were measured for inelastic scattering to the N^{14} states between 3.95 and 7.03 Mev. The relative cross sections are found to be in rather good agreement with shell-model predictions. (auth)

6243 PHOTODISINTEGRATION OF He^3. B. L. Berman, L. J. Koester, Jr., and J. H. Smith (Univ. of Illinois, Urbana). Phys. Rev., 133: B117-29(Jan. 13, 1964).

The 90° photodisintegration cross sections for He^3 were measured for incident photon energies between 8.5 and 21.5 Mev by detecting proton-deuteron coincidences in CsI(Tl) scintillators immersed in 1 atm of gas. The source of γ rays was the bremsstrahlung beam of a 22-Mev betatron. The simultaneous output pulses from the coincidences were displayed on a dual-beam oscilloscope and photographed. The particle energies were determined by pulse-height measurement, and electrons were rejetced by pulse-shape analysis. The peak cross section for the $He^3(\gamma,p)d$ reaction, which is very sensitive to the nuclear size, occurs at 10.8 ± 0.3 Mev and equals 0.092 ± 0.004 mb/sr. Gaussian ground-state wave functions for He^3 fail to predict the shape of the cross-section curve. The modified exponential wave function of Gunn and Irving gives a good fit for a root-mean-square nuclear radius of 1.94 F (corresponding to a charge radius of 2.1 F). The He^3 charge form factor calculated with this wave function agrees very well with the electron scattering measurements of Collard and Hofstadter for small momentum transfers q and deviates by 20% only at $q^2 = 5$ F^{-2}. Also, some information was acquired about the competing three-body photodisintegration process by detecting proton-proton coincidences in the cases where the angle between the two outgoing protons was near either 90 or 180°. (auth)

6244 EXPERIMENTAL STUDY OF PARITY CONSERVATION IN Λ° PRODUCTION IN CARBON NUCLEI USING INCIDENT π^- OF 2.0 Bev/c MOMENTUM. R. Ehrlich and J. K. Kim (Columbia Univ., New York). Phys. Rev., 133: B132-3(Jan. 13, 1964).

Parity conservation was tested for the Λ° production processes: $\pi^- + N \rightarrow \Lambda^\circ +$ anything, where the nucleon N is in a carbon nucleus. Approximately 120,000 pictures were taken of a propane bubble chamber exposed to a π^- beam of 2.0 Bev/c momentum. On the basis of 486 events, of which all but 23 were identified without ambiguity as Λ°, no indication of parity nonconservation was found. This result rests on the fact that the average Λ° polarization $\overline{P}$ in the production plane was found to be consistent with the value zero within the statistical error. The values found for two components of $\overline{P}$ in the production plane are: -0.08 ± 0.12 and 0.00 ± 0.12, using the value +0.63 for α, the asymmetry parameter. (auth)

6245 BINDING ENERGY OF A Λ-PARTICLE IN NUCLEAR MATTER AND THE Λ-NUCLEON INTERACTION. B. W. Downs (Univ. of Colorado, Boulder) and W. E. Ware. Phys. Rev., 133: B133-41(Jan. 13, 1964).

The binding energy D of a Λ-particle in nuclear matter is calculated with the independent-pair approximation for seven central two-body Λ-nucleon potentials. These potentials are consistent with the binding energy of $_\Lambda He^5$ and

therefore represent the spin-averaged Λ-nucleon interaction in S states; they have hard cores of radius 0.4 F or 0.6 F and two-parameter attractive wells with ranges suggested by consideration of the two-pion-exchange mechanism. A simple approximation to the Bethe-Goldstone function is suggested; its use permits D and the partial-wave contributions to D to be evaluated easily. When the S-wave Λ-nucleon potentials are assumed to be appropriate to all angular momentum states, the calculated values of D, corresponding to a nucleon density equal to the central density in heavy nuclei, are consistent with empirical estimates in the range 30–40 Mev for most of the potentials considered. If the correct value of D is close to 30 Mev, some reduction in the strength of the longer ranged potentials may be required in odd-parity states (at least in P states) to bring about agreement; for the shorter ranged potentials considered, no such reduction would be required. If the correct value of D is close to 40 Mev, odd-parity suppression would not be indicated even for the longer ranged potentials. The first three partial-wave contributions to D, as well as D itself, are given for each potential, and the dependence of these on the hard-core radius and on the shape and range of the attractive well is discussed. (auth)

6246 RELATIVISTIC CORRECTIONS IN THE THEORY OF MUON CAPTURE. B. Goulard, G. Goulard, and H. Primakoff (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 133: B186-90(Jan. 13, 1964).

Computations are presented in closure approximation on the effect of relativistic corrections (~[velocity of capturing proton]/[velocity of light]) on calculated muon total capture rates. A numerical estimate is made for the cases $\mu^- + He^3 \rightarrow H^3 + \nu_\mu$ and $\mu^- + He^4 + \nu_\mu$, and a comparison with experiment is given. (auth)

6247 THEORY OF RESONANCE FREQUENCY SHIFT DUE TO RADIATION FIELD. Masataka Mizushima (Univ. of Colorado, Boulder). Phys. Rev., 133: A414-18(Jan. 20, 1964).

A formalism is developed to calculate radiative processes and is applied to the shift of resonance frequency due to the radiation field itself. The zeroth approximation gives the Bohr resonance condition, while the next approximation gives a shift proportional to the photon density. The first-order shift is made of two terms: electric and magnetic. They can be interpreted as second order Stark effect and Zeeman effect due to the oscillating field, respectively. A comparison with experimental data on the Cs atom is made. A good agreement is obtained by choosing the value of parameters suitably. These values of parameters can be checked by a future experiment. (auth)

6248 ON THE LIFETIME OF THE ODD PARITY LEVEL IN ^{144}Nd. P. Rice-Evans (London Univ.). Proc. Phys. Soc. (London), 82: 914-17(Dec. 1, 1963).

The resonant elastic scattering of γ rays by Nd^{144} was investigated, and the small cross section observed indicates a lower limit of $(2.0 \pm 0.4) \times 10^{-14}$ seconds for the lifetime of the 2.18-Mev (1^-) level. (auth)

6249 DETERMINATION OF THE L/K ELECTRON CAPTURE RATIO IN THE DECAY OF ^{131}Ba TO THE 620 kev LEVEL IN ^{131}Cs. K. M. Smith and B. R. Joshi (Glasgow Univ.). Proc. Phys. Soc. (London), 82: 918-22(Dec. 1, 1963).

Using an internal source scintillation spectrometer, the L/K electron capture ratio in the decay of Ba^{131} to the 620-kev level in Cs^{131} was found to be 0.135 ± 0.009. This result may be compared with the theoretical value of 0.131, which is obtained using a value of 1.7 Mev for the atomic mass difference between the ground states of Ba^{131} and Cs^{131}. Alternatively, assuming the electron wave functions to be correctly determined by theory, the upper limit for the L/K ratio may be used to set a lower limit to the transition energy available in the decay. The value obtained by this method for the ground state atomic mass difference is 1.06 Mev, which is consistent with the observed existence of an electron capture decay branch to the 1.04-Mev level in Cs^{131}. (auth)

6250 THE W^{189}–Re^{189} DECAY CHAIN. J. Flegenheimer, G. B. Baró, and M. Viirsoo (Comisión Nacional de Energia Atómica, Buenos Aires). Radiochim. Acta, 2: 7-8(Oct. 1963).

W^{189} was found by an Os(n,α) reaction. Its half life is 11 min and the maximum β energy around 1.4 Mev. A tungsten nuclide with this half life could not be obtained with a W(d,p) reaction. The 23-hr Re^{189} reported by Crasemann, Emery, and Kane, was prepared using enriched osmium isotopes. Its maximum β energy is about 0.8 Mev and γ lines of 65, 140, 170, and 225 kev were observed. (auth)

6251 A NUMBER OF INTERFERENCE PHENOMENA IN QUANTUM TRANSITIONS. M. I. Podgoretskii and O. A. Khrustalev. Usp. Fiz. Nauk, 81: 217-47(Oct. 1963). (In Russian)

Various interference methods are presented from a unified point of view. An atom having a superfine structure, or a nucleus with a spin different from zero placed in an external magnetic field are examples of systems having split energy levels. The super-position of two stationary states leads to a sort of non-stationary state whose properties vary with time. The decay of a π^+ meson leads to formation of a polarized μ^+ meson, which forms a muon. The stationary states of the muon can be considered to be a singlet state and a triplet state. The transitions between 2P and 2S excited states of hydrogen are discussed in terms of their wave functions. It is pointed out that positrons change from the ortho- to the para state and back again on applications of an external magnetic field. K^0 and $\widetilde{K}^0$ are periodically changed from one state to another. Interference or "modulation" effects are possible, when a transition from an excited state to a ground state takes place by two or more paths. The radiation intensity can undergo periodic changes in time and space. If two frequencies are "mixed," it is possible to obtain combinations of the differences in the initial frequencies, and to study the splitting of quantum levels. Line broadening discussed as an experimental limitation of the "modulation" method ("modulation" is preferred to "Larmor spin precession"). The effect of a magnetic field on γ-γ coincidences leads to corresponding "modulation" in delayed γ-γ transitions in many cases. Interferences between a number of levels on imposing an electric or magnetic field are discussed. (129 references) (TTT).

6252 MONOPOLE TRANSITIONS OF ATOMIC NUCLEI. L. A. Borisoglebskii. Usp. Fiz. Nauk, 81: 271-334(Oct. 1963). (In Russian)

An electric monopole transition (EO transition) is due to the interaction of the nucleus with the electron shell of the atom. The excited nucleus is most likely to discharge its excess energy by emission of a conversion electron or by formation of an electron-positron pair. The probability of an EO transition by way of a conversion electron can be described by the expression: $W_e = \rho^2 \Omega_e$. Here, ρ is the number of states per unit interval of energies, and the multiplier Ω_e does not depend on the spin states of the nucleus, but is completely determined by the electron wave function. The value of Ω is a maximum for the K shell, is

smaller for the L_I shell, and is still smaller for the M_I subshell. Numerical values of Ω_K, K/L_p, and L_I/L_{II} are presented for a number of EO transitions. The probabilities for the formation of an electron-positron pair are also given. Methods of calculating a mixed EO + MI + E2 transition are given. The average lifetime of an excited nucleus is calculated for different types of O-O transitions. Monopole transitions in O^{16}, Po^{214}(RaC'), $Ge^{72,70}$, Zr^{90}, Pt^{196}, Ce^{140}, Sm^{152}, and Gd^{152} are discussed. Theoretical estimates of the nuclear matrix element of the monopole are performed on the basis of various nuclear models. The theoretical and experimental values are compared for various nuclei. (216 references). (TTT)

6253 CONCERNING COOPERATIVE BEHAVIOR OF OUTER NUCLEONS IN THE OSCILLATOR MODEL WITH QUADRUPOLE EXCHANGE EFFECTS. Siegfried Seyferth (Universität, Gottingen, Ger.). Z. Naturforsch., 18a: 1049-58(Oct. 1963). (In German)

The question of whether the Elliott model nucleus can be interpreted as a rotating one is discussed. The classical interpretation of the quadrupole interaction explains the prolate deformation of the nucleus and yields a pure rotation of the classical system of orbits. The quantum mechanical treatment shows that the states of the Elliott model that are analogous to the rotating states of the rotational model are rotating states, too. This involves the existence of a (positive) intrinsic quadrupole moment. (auth)

6254 ELASTIC SCATTERING OF DEUTERONS ON NITROGEN, OXYGEN, AND ARGON. O. F. Nemets, F. Pikar, L. I. Slyusarenko, and V. V. Tokarevskii (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 850-1(Oct. 1963). (In Russian)

Angular distributions are obtained for 13.6-Mev deuterons scattered on nitrogen, oxygen, and argon nuclei. A gas target was employed. Particle identification is realized by the E, dE/dx method. The angular distributions possess a pronounced diffraction structure. (auth)

6255 SECONDARY REACTIONS OF ASTATINE PRODUCTION DURING BOMBARDMENT OF Bi AND Pb WITH 3 TO 10 Bev PROTONS. N. S. Mal'tseva, V. N. Mekhedov, and V. N. Rybakov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 852-6(Oct. 1963). (In Russian)

The cross sections for At^{211} production by 3-, 6-, and 10-Bev proton bombardments of bismuth and lead are determined by a radiochemical method. For bismuth the cross sections are (1.5 ± 0.5), (2.0 ± 0.6), and $(1.0 \pm 0.3) \times 10^{-28}$ cm^2 and for lead (3.3 ± 1.0), (5.0 ± 1.5), and $(10 \pm 4) \times 10^{-30}$ cm^2, respectively. Yields of the isotopes At^{210}, At^{209}, At^{208}, and At^{207} from bismuth with respect to the At^{211} yield at 10 Bev are determined by measuring the α-spectra. The relative yields are 1.2 ± 0.72, 0.88 ± 0.08, 0.89 ± 0.47, and 0.53 ± 0.04 respectively. The At^{209} and At^{207} yields relative to the At^{211} yield in lead at the same proton energy are 1.87 ± 0.22 and 0.98 ± 0.08. The data obtained are compared with the cross sections for At^{211} production and the relative yields of light astatine isotopes produced by bombarding the same targets with protons of smaller energies and also with other data on the fragmentation process. (auth)

6256 SPECTRUM OF γ-RAYS PRODUCED IN RESONANCE CAPTURE OF NEUTRONS. V. Ratynskii, K. G. Ignat'ev, I. V. Kirpichnikov, F. N. Belyaev, and S. I. Sukhoruchkin (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 870-4(Oct. 1963). (In Russian)

The spectrum of γ rays emitted as a result of neutron capture on resonance levels of a number of isotopes of W, Hg, Pt, and Au was investigated by aid of a program time-pulse height analyzer. A single crystal γ spectrometer (NaI crystal) was employed for the measurements. For Au the spectrum was measured with a pair spectrometer. Significant fluctuations in the unresolved part of the spectra ($E_\gamma \sim 5$ to 6 Mev) were observed that may be due to a large probability of single particle transitions. No significant changes in the shape of the γ-ray spectra were observed by exciting levels of the Hg^{199} isotope with different spins. (auth)

6257 SPIN DEPENDENCE OF RESONANCE LEVEL DENSITY. K. G. Ignat'ev, I. V. Kirpichnikov, and S. I. Sukhoruchkin (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 875-81(Oct. 1963). (In Russian)

The dependence of the resonance level density on spin magnitude is investigated. The ratio of the number of resonances with a given spin I (I = 0 or 1) is in accordance with the $N_I \sim (2I + 1)$ law. (auth)

6258 INELASTIC SCATTERING OF γ-QUANTA ON Ag^{107} NUCLEI. O. V. Bogdankevich, B. S. Dolbilkin, L. E. Lazareva, and F. A. Nikolaev (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 882-91(Oct. 1963). (In Russian)

The $Ag^{107}(\gamma,\gamma')Ag^{107m}$ yield was measured with the FIAN 30-Mev synchrotron by the induced activity method for various x-ray energies, $E_{\gamma\,max}$, varying from 6 to 26 Mev. The cross section for the reaction $Ag^{107}(\gamma,\gamma')Ag^{107m}$ calculated from the yield curve has two peaks, one near the threshold of the (γ,n) reaction and the second in the region 18 to 24 Mev. The peak cross section values are, respectively, 1.7 and 2.9 mb; the peak half-widths are approximately 4 Mev. The ratio of the cross section for inelastic scattering of γ-quanta on Ag^{107} nuclei to the photoneutron cross section σ_n (sum of cross sections for the reactions $Ag^{107}(\gamma,n) + Ag^{107}(\gamma,2n) + Ag^{107}(\gamma,pn)$) in the region of the first maximum satisfactorily agrees with that expected according to the statistical theory. In the region of the second maximum, the ratio $\sigma(\gamma,\gamma')/\sigma_n$ exceeds the calculated one by several orders of magnitude. (auth)

6259 MEASUREMENT OF THE LIFETIME OF THE LEVELS IN THE Eu^{152}, Ag^{110}, AND Cs^{134} NUCLEI PRODUCED IN (n,γ)-REACTIONS. A. M. Berestovoi, D. M. Kaminker, and I. A. Kondurov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 45: 892-6(Oct. 1963). (In Russian)

Lifetimes are measured for the excited states of the odd–odd nuclei Eu^{152}, Ag^{110}, and Cs^{134} produced as a result of neutron capture. The limits of the lifetime are estimated for the 90-kev level in Eu^{152}: $3 \times 10^{-7} \leq T_{1/2} \leq 1 \times 10^{-6}$ sec. The value $T_{1/2} = (3.7 \pm 0.2) \times 10^{-8}$ sec. is obtained for the 116-kev level in Ag^{110}. A set of lines with $T_{1/2} = (5.7 \pm 0.7) \times 10^{-8}$ sec. was detected in the Cs^{134} spectrum. Schemes of the lower excited states of Eu^{152} and Ag^{110} are proposed on basis of the data obtained. (auth)

6260 TWO-NEUTRON TRANSFER DURING N^{15} BOMBARDMENT OF SEPARATED $Zr^{90,92,94}$ ISOTOPES. V. V. Volkov, L. Pomorskii, Ya. Tys, Ya. Vil'chinski (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 897-903(Oct. 1963). (In Russian)

Targets consisting of separated Zr^{90}, Zr^{92}, and Zr^{94} were irradiated with N^{15} ions accelerated in the internal beam of the JINR heavy ion cyclotron. The aim of the

experiment was to investigate the effect of nuclear structure on the probability of two-neutron transfer. The effective cross sections of the reactions were measured on the basis of delayed neutron activity of N^{17} nuclei. The measurements were carried out for N^{15} energies between 70 and 120 Mev (lab. system). The ratios of the cross sections for two-neutron transfer as a result of irradiation of Zr^{94}, Zr^{92}, and Zr^{90} targets change from 17:6:1 for 60-Mev N^{15} ion energies (in the c. m. s.) to 6:4:1 at 100 Mev. (auth)

6261 RATIO OF CROSS SECTIONS FOR FORMATION OF THE Sc^{44} AND Sc^{44m} PAIR IN HEAVY ION REACTIONS. V. V. Bredel', B. A. Gvozdev, and V. A. Fomichev (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 904-9(Oct. 1963). (In Russian)

The energy dependence of the ratios of the cross sections for formation of the isomer pair in the reactions $Al^{27}(Ne^{20}, 2pn)$, $Al^{27}(Ne^{22}, \alpha n + 2p3n)$, and $S^{32}(O^{16}, 3pn)$ is measured. The excitation functions for reactions leading to the formation of Sc^{44m} and Sc^{44} and also Sc^{43} and Sc^{46} have a form that is characteristic of reactions occurring via the compound nucleus. On the basis of the isomer ratio energy dependence it is concluded that scandium isotopes are produced in reactions with collision parameters corresponding to angular momenta < 25 ħ. (auth)

6262 (He^3,α) REACTION ON C^{12} AND Mg^{24} NUCLEI. V. M. Pankratov and I. N. Serikov. Zh. Eksperim. i Teor. Fiz., 45: 910-12(Oct. 1963). (In Russian)

The differential cross sections for the $C^{12}(He^3,\alpha)C^{11}$ and $Mg^{24}(He^3,\alpha)Mg^{23}$ reactions were measured for six ion energies between 26 and 33 Mev. It is shown that the angular dependences are different for these reactions and this may be regarded as an indication that the mechanisms of the two reactions are different. (auth)

6263 ON THE NATURE OF HIGHLY EXCITED LEVELS IN W^{182}. S. V. Starodubtsev, R. B. Begzhanov, and S. L. Rakovitskii (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Zh. Eksperim. i Teor. Fiz., 45: 921-6(Oct. 1963). (In Russian)

The nature of hard γ-quanta from W^{182} is studied by measuring internal conversion in β-decay of Ta^{182}. The experimental ratios of the reduced probabilities are compared with the predictions of various theoretical nuclear models. (auth)

6264 INELASTIC SCATTERING OF 14-Mev NEUTRONS ON Mg^{24}. B. A. Benetskii, Yu. P. Betin, and Ya. Gonzatko (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 927-31(Oct. 1963). (In Russian)

The cross section for excitation of the first excited level of the Mg^{24} nucleus by scattering of 14-Mev neutrons is measured by comparison to the cross section for the reaction $Mg^{24}(n,p)Na^{24}$. (auth)

6265 QUASISTATIC DROP MODEL AS AN APPROXIMATION TO THE STATISTICAL MODEL. V. M. Strutinskii and A. S. Tyapin. Zh. Eksperim. i Teor. Fiz., 45: 960-5 (Oct. 1963). (In Russian)

It is shown that the problem of determining the equilibrium distribution of nucleon density in the quasiclassical statistical model of nuclear matter under the assumption of low compressibility reduces to determination of the equilibrium shape of an effective nuclear surface. In this approximation the statistical and drop models are identical. Corrections to the drop model due to the curvature of the diffuse layer and to finite compressibility are derived. (auth)

6266 ON THE MECHANISM OF TOTAL NUCLEAR DISINTEGRATION. Yu. A. Berezhnoi, A. P. Klyucharev, Yu. N. Ranyuk, and N. Ya. Rutkevich (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 1030-5(Oct. 1963). (In Russian)

Total angular momenta for each star of the reaction $C^{12} + C^{12} \rightarrow 6\alpha$ that was studied previously are determined on the basis of the statistical model of direct nuclear decay. A mechanism is indicated that differs from direct nuclear decay and which also leads to total disintegration of carbon atoms into α particles. Corrections to the statistical model of direct nuclear decay are discussed. (auth)

6267 A PHENOMENOLOGICAL APPROACH TO THE THEORY OF THE NUCLEUS. A. B. Migdal and A. I. Larkin. Zh. Eksperim. i Teor. Fiz., 45: 1036-50(Oct. 1963). (In Russian)

A method for calculation of nuclei is developed in which observable quantities are expressed in terms of several constants that are the same for all nuclei (besides light ones) and for all types of transitions near the Fermi boundary. Some equations are deduced from which the frequencies and probabilities of single-particle and collective transitions in nuclei can be expressed in terms of constants in the theory. (auth)

6268 ACCURACY OF THE GENERALIZED HARTREE-FOCK METHOD IN NUCLEAR PHYSICS. I. N. Mikhailov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1102-10(Oct. 1963). (In Russian)

A simple procedure is suggested for decreasing the errors that arise when the Schroedinger equation is solved by methods that do not take into account with sufficient accuracy any of the conservation laws. The procedure is based on an approximate representation of the operator of function projection on function space with the required value of the quantum number, corresponding to the conservation law. The method may be employed for refinement of the u, v-transformation in the superfluid model of the nucleus and for more accurate determinations of the moments of inertia. The method is employed for estimating the accuracy of the u, v-transformation method. It is shown that the errors in the values of the excitation energies of the low states determined by the u, v-transformation method do not exceed 15%. It is also shown that if projecting is taken into account, the variation of the correlative function C for various excited states of the system become significantly smaller. (auth)

6269 ANGULAR DISTRIBUTION OF RECOIL NUCLEI IN THE $\mu^- + He^3 \rightarrow H^3 + \nu$ REACTION. G. Ya. Korenman and R. A. Eramzhyan (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1111-13(Oct. 1963). (In Russian)

A formula for the angular distribution of tritium produced in the capture of partially polarized μ^- mesons by He^3 nuclei is derived by taking into account hyperfine structure. The dependence of the asymmetry coefficient on the induced pseudoscalar interaction constant is investigated. (auth)

6270 ELECTROMAGNETIC EMISSION OF ATOMIC ELECTRONS DURING β-DECAY. A. I. Greiser (Rostov State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 45: 1133-5(Oct. 1963). (In Russian)

Emission of atomic electrons during β decay, which is a second-order effect with respect to electromagnetic interaction, is considered. Calculations for β decay of S^{35} show that the main contribution is from electron emission of the magnetic type from the outer shell. The theoretical estimations are in good agreement with the experiments. (auth)

6271 SCATTERING OF ELECTRONS BY NUCLEI ACCORDING TO THE α-PARTICLE MODEL OF THE NUCLEUS. V. Vadia, E. Inopin, and M. Yusef. Zh. Eksperim. i Teor. Fiz., 45: 1164-6(Oct. 1963). (In Russian)

Inelastic scattering of electrons on the O^{16} nucleus and on a nucleus consisting of an α-particle core and a weakly bound neutron is considered. Gamma-transitions in the O^{16} nucleus are also considered. (auth)

6272 DETERMINATION OF THE INTERACTION BETWEEN NUCLEONS ON BASIS OF ELECTRON SCATTERING ON NUCLEI. V. P. Yakovlev (Moscow Inst. of Engineering Physics). Zh. Eksperim. i Teor. Fiz., 45: 1218-24(Oct. 1963). (In Russian)

Scattering of fast electrons on nuclei is studied. The nucleus is regarded as a Fermi fluid consisting of two types of particles interacting in an arbitrary way. It is demonstrated that particle interaction in the nucleus modifies the scattering cross section. The cross section formulas contain spherical harmonics of the amplitudes for scattering of the same or different quasiparticles into an angle 0° on the Fermi surface. (auth)

6273 MEASUREMENTS OF CROSS SECTIONS IN $C^{12}(p,pn)C^{11}$ REACTIONS AT 9 Bev. B. I. Bekker, V. S. Pantuev, V. A. Sviridov, and M. N. Khachaturyan (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1269-70(Oct. 1963). (In Russian)

A 3 × 3 × 3 cm plastic scintillator was used for measuring cross sections of $C^{12}(p,pn)C^{11}$ reactions at 9 Bev. A total proton flux of $\sim 2 \times 10^6$ was determined by tracks in a 200-μ emulsion. Beam angular distribution was measured for determining contributions of secondary particles. Tracks with a dip of ±45′ were considered as primary tracks. Mean fluctuations in the proton flux did not exceed 15%. It was found that 16% of the C^{11} is formed by secondary particles. The result of three expositions showed cross section values of 25.2, 26.1, and 27.2 mb, with a statistical order of error of 1.0 mb. Corrected results yield δ = 26.2 ± 1.5 mb. (R.V.J.)

6274 TEMPERATURE INVESTIGATION OF MÖSSBAUER SPECTRA FOR Fe^{57} AND Sn^{119} NUCLEI IN ANTIFERROMAGNETIC COMPOUND $FeSn_2$. V. I. Nikolaev, Yu. I. Shcherbina, and S. S. Yakimov. Zh. Eksperim. i Teor. Fiz., 45: 1277-80(Oct. 1963). (In Russian)

Temperature measurements were made on the Mössbauer absorption of 14.4 and 23.8 kev γ quanta by Fe^{57} and Sn^{119} in $FeSn_2$. Calculations of splitting magnitudes for the Fe^{57} ground and first excited levels showed $g_0 = 1.37 \pm 0.15$, $g_1 = 0.77 \pm 0.05$ mm/sec, and $g_0/g_1 = 1.78 \pm 0.15$. The ratio g_0/g_1, does not depend on the local magnetic field and exhibits the characteristics of a given isotope. Mössbauer parameters and tabulated data are used for determining the magnetic fields acting on Fe and Sn nuclei in $FeSn_2$ at room temperature. (R.V.J.)

6275 MEASUREMENT OF ASYMMETRY IN THE $N^{14}(d,p)N^{15}$ REACTION ON ELASTICALLY SCATTERED DEUTERONS. Yu. V. Gofman, V. N. Dobrikov, N. I. Zaika, A. V. Mokhnach, and O. F. Nemets (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 1317-18(Nov. 1963). (In Russian)

The vector polarization of 13.6 Mev deuterons elastically scattered on Ta is investigated. The (d,p) reaction on N^{14} is employed as the analyzer. Within statistical errors left-right proton asymmetry measured for first scattering angles between 30 and 90° is zero. (auth)

6276 MILLISECOND THALLIUM ISOMERS. A. G. Demin, Yu. P. Kushakevich, E. A. Makoveev, I. M. Rozman, and A. F. Chachakov. Zh. Eksperim. i Teor. Fiz., 45: 1344-51(Nov. 1963). (In Russian)

A method for investigating short lived isomers (10^{-4}–10 sec) is described. The isomers Tl^{199} and Tl^{201} were identified and a new isomer Tl^{200} with a half period 34.1 ± 1.0 msec and 205- and 520-kev γ lines was detected by irradiating gold with 22-Mev α particles and mercury with 11-Mev deuterons. (auth)

6277 THE THREE α-PARTICLES FORMATION REACTIONS IN THE INTERACTIONS BETWEEN B^{10} IONS AND LIGHT NUCLEI. S. N. Shumilov, A. P. Klyucharev, and N. Ya. Rutkevich (Inst. of Physics and Tech., Acad. of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 1356-9(Nov. 1963). (In Russian)

The interaction between light emulsion nuclei and B^{10} ions was studied. The discriminative emulsions were processed, and all the stars parameters were measured. The subsequent detailed analysis of the kinematics enabled the reactions $C^{12} + B^{10} \rightarrow B^{10} + 3\alpha$; $N^{14} + B^{10} \rightarrow C^{12} + 3\alpha$; $O^{16} + B^{10} \rightarrow N^{14} + 3\alpha$; and $N^{14} + B^{10} \rightarrow 6\alpha$ to be identified. The average cross sections were measured in the B^{10} energy region from 30 to 90 Mev. (auth)

6278 INVESTIGATION OF α-DECAY OF CURIUM ISOTOPES. B. S. Dzhelepov, R. B. Ivanov, V. G. Nedovesov, and V. P. Chechev. Zh. Eksperim. i Teor. Fiz., 45: 1360-71(Nov. 1963). (In Russian)

The α spectra of Cm^{242}, Cm^{243}, Cm^{244}, Cm^{245}, and Cm^{246} are investigated with a magnetic α spectrometer with focusing at an angle $\pi\sqrt{2}$. The energies and intensities of the α transitions of the isotopes are determined. A possible interpretation of some excited states of Pu^{239} and Pu^{241} nuclei produced in α decay of Cm^{243} and Cm^{245} is discussed on the basis of the Nilsson scheme. Decay schemes for the Cm isotopes are presented. (auth)

6279 INVESTIGATION OF DECAY OF Eu^{147} AND Eu^{148} BY THE COINCIDENCES PULSE SUMMATION TECHNIQUE. V. R. Burmistrov and A. D. Vangai (Inst. of Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 45: 1380-4(Nov. 1963). (In Russian)

The $\gamma\gamma$-coincidence technique in conjunction with a scintillation spectrometer was applied for investigating decay of long-lived europium isotopes produced as a result of disintegration of tantalum by 660-Mev protons. A search was made for a 900-kev level that may be excited in the decay of Eu^{147}. No experimental proof of the existence of the level was obtained. The well known two-step transitions in Eu^{148} decay are confirmed. A procedure for reliable identification of levels in the Hoogenboom method is proposed in the presence of cascade transitions from higher levels. (auth)

6280 INVESTIGATION OF THE RADIATIONS FROM Al^{26m}, S^{31}, Ti^{43} AND Mn^{57}. S. S. Vasilev and L. Ya. Shavtvalov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1385-6(Nov. 1963). (In Russian)

The β spectra of short-lived Al^{26m}, S^{31}, Ti^{43}, and Mn^{57} are investigated on a magnetic β spectrometer. The upper limit of the β spectrum of Ti^{43} is in good agreement with theory; the half-life is 0.4 ± 0.05 sec. It is found that the Mn^{57} β spectrum consists of two partial β spectra with an upper limit at 2550 ± 50 and 1100 ± 100 kev and relative intensities of 82 and 18%. A value of 4200 ± 100 kev was obtained for the end point energy of the β spectrum of S^{31}. The end point energies and lifetimes in the other cases agree with available data within the experimental errors. (auth)

6281 ANGULAR DISTRIBUTION OF THE POLARIZATION OF NEUTRONS FROM THE $C^{12}(d,n)N^{13}$ REACTION. N. P. Babenko, I. O. Konstantinov, and Yu. A. Nemilov

(Inst. for Radium, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1389-92(Nov. 1963). (In Russian)

The angular distribution of the polarization of neutrons from the $C^{12}(d,n)N^{13}$ reaction is measured for $l_p = 1$ and the results are compared with the data of Levintov and with the variation of polarization in the stripping reaction $C^{12}(d,p)C^{13}$. (auth)

6282 NEUTRON POLARIZATION IN THE REACTIONS $T(p,n)He^3$ AND $D(d,n)He^3$. N. V. Alekseev, U. R. Arifkhanov, N. A. Vlasov, V. V. Davydov, and L. N. Samoilov. Zh. Eksperim. i Teor. Fiz., 45: 1416-24(Nov. 1963). (In Russian)

Asymmetry of n–α scattering through an angle $\theta_n = 123 \pm 5°$ is measured for neutrons from the reaction $T(p,n)He^3$ for E_p lying between 12 and 17 Mev and $D(d,n)He^3$ for E_d between 12 and 20 Mev. The analyzer employed was a gas helium chamber–scintillator in coincidence with two neutron counters. In order to exclude geometric asymmetry effects the neutron spin was rotated over 90° in a magnetic field. In the $T(p,n)He^3$ reaction an asymmetry of 20% was observed at an angle of ≈45° for all energies investigated. In the $D(d,n)He^3$ reaction the asymmetry at 30° reached $(32.5 \pm 6.0)\%$ at $E_d = 14$ Mev and with further increase of energy it slowly decreased. The directions of neutron polarization in both reactions were opposite. (auth)

6283 ATOMIC NUCLEUS DEFORMATIONS IN CALCULATIONS OF THE ISOTOPIC SHIFT OF SPECTRAL LINES. F. A. Babushkin. Zh. Eksperim. i Teor. Fiz., 45: 1479-83(Nov. 1963). (In Russian)

The effect of axial and nonaxial deformations on the isotopic shift of spectral lines is calculated with an accuracy to terms of the order of β^3. Deformation compressibility in terms of the same order of magnitude were taken into account. Satisfactory agreement between the theoretical and experimental values was obtained for all pairs of isotopes for which the experimental values of the isotopic shift constants and deformation parameters are known with the exception of the pair Nd^{146} and Nd^{148}. It follows from the calculations that the effect of nonaxiality of the nuclei can be completely neglected. (auth)

6284 CALCULATION OF THE SPECTRUM OF THE $_{86}Rn^{218}$ NUCLEUS. I. M. Band (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 45: 1535-43(Nov. 1963). (In Russian)

The spectrum of the nucleus Rn^{218}, which possesses ten extra nucleons, is calculated. It is demonstrated that the lower levels of the spectra of multinucleon problems can be calculated by employing the self-consistent potential $V_C + V_S$ and the pair potential V_p determined by analyzing nuclei with one or two nucleons in addition to the core. The good agreement between the calculated and experimental values of the binding energies of ten nucleons indicates that if forces of a different kind do exist, their contribution to the energy should be sufficiently small. It is found that the second excited level in the Rn^{218} spectrum to which, by analogy with vibrational spectra, a spin and parity of 2^+ was ascribed, in reality possesses the characteristic 0^+. It is demonstrated that besides levels known from the experiments a number of other levels should exist. Tables of parentage coefficients for separation of one or two particles are computed for all states $\frac{1}{2} \leq J \leq \frac{13}{2}$. (auth)

6285 ON SCREENING IN PAIR CONVERSION. V. G. Gorshkov and K. Ridel (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 45: 1603-5(Nov. 1963). (In Russian)

The effect of screening on the pair conversion coefficient is taken into account in the first approximation in perturbation theory. (auth)

6286 THEORY OF THE HYPERFINE STRUCTURE OF MÖSSBAUER LINES IN PARAMAGNETIC SUBSTANCES. A. M. Afanasev and Yu. Kagan. Zh. Eksperim. i Teor. Fiz., 45: 1660-77(Nov. 1963). (In Russian)

The hyperfine structure of nuclear lines in paramagnetic substances in the absence of a magnetic field is considered. Relaxation of the electron angular momentum is assumed to be of a spin-lattice nature. A diagram method is developed that yields the explicit form of the corresponding correlative function and hence the absorption spectrum of γ quantum in crystals over a broad range of temperature and for an arbitrary relation between the relaxation frequencies and characteristic frequencies of the hyperfine interaction. The results are analyzed for limiting cases and also in simple cases corresponding to an electron angular momentum $J = \frac{1}{2}$ and to a large electron angular momentum. (auth)

6287 NUCLEAR REACTIONS. VOLUME I. P. M. Endt and M. Demeur, eds. Series in Physics. Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons., Inc., 1959. 512p. $12.50.

Nuclear reactions are defined as those in which the initial state has two components: the target nucleus and the bombarding particle or radiation. A restriction is also imposed on the bombarding energy such that it is below the threshold of strange particle production. Experimental surveys, theoretical papers concerned with the reaction dynamics, and theoretical contributions to nuclear models are presented. The book contains 10 chapters, each of which is separately abstracted in NSA. (R.E.U.)

For abstracts of individual chapters see: 6288, 6289, 6290, 6291, 6292, 6293, 6294, 6295, 6296, and 6297.

6288 THEORY OF THE NUCLEUS AS A MANY-BODY SYSTEM. R. J. Eden (Clare Coll., Cambridge, Eng.). p.1-41 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

A summary of literature pertaining to nuclear many-body theory is presented. Included in the discussion are two-particle interactions, many-body perturbation theory, the Hartree-Fock approximation, the reaction matrix, self-consistent equations for a finite nucleus, the Brueckner approximation for infinite nuclear medium, correction terms for the infinite nuclear medium and the finite nucleus, the shell and optical models, and high-energy nuclear reactions. 45 references. (R.E.U.)

6289 THE SHELL MODEL. J. P. Elliott (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.42-85 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

The stages of development of the nuclear shell model from the simple single-particle version to the intermediate-coupling version are reviewed. Various applications of the intermediate-coupling version are discussed. 64 references. (R.E.U.)

6290 HEAVY ION REACTIONS. J. H. Fremlin (Univ. of Birmingham, Eng.). p.86-158 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

Fields of application of heavy-ion bombardment are discussed. Various reactions of heavy ions with elements that

span the entire periodic table are discussed. It is concluded that reaction mechanisms change several times as the periodic table is crossed. Simple neutron transfer appears to take place at all energies from the region of the potential barrier upwards, and with targets of any atomic number. Forms of direct interaction, excitation, and deexcitation are discussed for light to heavy nuclei. 42 references. (R.E.U.)

6291 ANGULAR CORRELATIONS AND POLARIZATION. L. J. B. Goldfarb (Univ. of Manchester, Eng.). p.159-214 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

Angular correlations of nuclear reactions with spinless radiation and some general results for nuclear reactions without regard to polarization are discussed. Correlations are applied to cascade-decay and specific nuclear processes. A description of polarization with polarization of spin-$\frac{1}{2}$ particles, gamma radiation, and particles of arbitrary spin is presented. 66 references. (R.E.U.)

6292 RESONANCE REACTIONS, THEORETICAL. Erich Vogt (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.215-58 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

Scattering of s-wave particles by a potential well, the formal theory of nuclear resonance reactions, resonance cross sections, and the relation of resonance parameters to nuclear properties are discussed. 60 references. (R.E.U.)

6293 RESONANCE REACTIONS, EXPERIMENTAL. H. E. Gove (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.259-317 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

The resonance region in light nuclei is discussed. The excitation energies for nuclei up to Z = 22 at which the nucleus is allowed to decay into a neutron, proton, deuteron, triton, He^3, or alpha particle are given. The reaction and differential and total scattering cross sections for various processes are discussed. The absolute yields and shapes of yield curves from resonance reactions are discussed. Angular correlation measurements at a single isolated resonance are presented. 84 references. (R.E.U.)

6294 THE STATISTICAL MODEL. K. J. Le Couteur (Australian National Univ., Canberra). p.318-55 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

Some experimental evidence for statistical interpretations in nuclear reactions is presented. The discussion includes the Weisskopf evaporation theory, cross sections for neutron and proton absorption, nuclear temperature, the evaporation spectrum, neutron and evaporation cascades, the neutron excess, spallation reactions, decay protons, evaporation cascade measurements for meteorites and μ meson capture, and the emission of light nuclear fragments. 75 references. (R.E.U.)

6295 NEUTRON RESONANCES IN HEAVY NUCLEI. D. J. Hughes and R. I. Zimmerman (Brookhaven National Lab., Upton, N. Y.). p.336-90 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

The nuclear structure inferred from nuclear reactions of low-energy neutrons is discussed. Many properties of nuclei are obtained experimentally from slow-neutron cross sections and are compared to theory. The analysis of and instruments used for determining neutron resonances are discussed. Radiation widths, level spacings, neutron widths, fission widths, strength functions, and nuclear radii are discussed. 21 references. (R.E.U.)

6296 A SURVEY OF SCATTERING AND REACTION EXPERIMENTS WITH MEDIUM ENERGY NUCLEONS AND ALPHA PARTICLES. P. C. Gugelot (Instituut voor Kernphysisch Onderzoek, Amsterdam). p.391-426 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

Experimental information is presented in light of developments in the single-particle picture and Bohr's compound nuclear model. A statistical theory of nuclear reactions with a Fermi gas model is presented. Elastic scattering of alpha particles and nucleons in the optical model is discussed. Alpha- and nucleon-induced reactions, surface interactions, and capture reactions are discussed. 158 references. (R.E.U.)

6297 NUCLEAR ROTATIONAL MOTION. A. K. Kerman (Massachusetts Inst. of Tech., Cambridge). p.427-93 of "Nuclear Reactions. Vol. I." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1959.

The present status of the theory of rotational states in nuclei and the expressions that are necessary for the interpretation of experimental information are discussed. The rotating nucleus is described in terms of the shell and collective models. The energy spectra and wave functions for even-even and odd nuclei, electric quadrupole moments and transitions, magnetic dipole moments and transitions, intensity and selection rules for gamma transitions between rotational bands, and the K selection rule in Coriolis interactions are discussed. Alpha and beta decay and neutron scattering by rotating nuclei are treated. Theoretical considerations include a unified model, spins and deformations in the deformed well, and approximate selection rules. 55 references. (R.E.U.)

Plasma Physics and Thermonuclear Processes

6298 (63-RL-3226E) LOW-DENSITY THETA PINCH EXPERIMENTS. L. M. Goldman, H. C. Pollock, J. A. Reynolds, and W. F. Westendorp (General Electric Co. Research Lab., Schenectady, N. Y.). Feb. 1963. 22p. (CONF-38-10)

From American Physical Society Division of Plasma Physics 4th Annual Meeting, Atlantic City, Nov.-Dec. 1962.

Experiments demonstrating that neutron production is possible in the absence of a reversed magnetic field and at pressures of the order of 5 μHg are described. Some characteristics of the plasma, its stability and duration, the appearance of oscillations, and the effect of impurities in the gas are discussed; and some of the techniques used to measure plasma β are described. (auth)

6299 (ASD-TDR-63-858) GENERATION OF NEGATIVE IONS IN A GAS DISCHARGE. RCA Victor Research Report No. 7-811-6. G. G. Cloutier and C. Richard (RCA Victor Co., Ltd. Research Labs., Montreal). Nov. 1963. Contract AF33(657)-7906. 50p.

The generation of heavy negative ions in a gas discharge was investigated. The negative ions were generated by producing a discharge through mixtures of electronegative gases (SF_6 and I) and argon. Measurements of total ion

currents showed that negative ion current densities of 0.4 mamp/cm² were obtained in the SF_6–Ar ion source and 0.24 mamp/cm² in the Ar–I discharge. Mass spectrometer measurements indicated that SF_6 is highly dissociated in the ion source and as a result it was found that the atomic fluorine (F^-) is the predominant ion in the ion beam extracted from the gas discharge. For the Ar–I gas discharge the ion beam was essentially that of atomic iodine (I^-). Langmuir probe measurements in the gas discharge ion source showed that in both types of gas mixture the negative ions are the most abundant charge carriers in the plasma. In SF_6–Ar mixtures the negative ion concentration is estimated at 99.8%, while for the Ar–I mixture the estimate of the negative ion concentration is 98%. The results indicate that an ion source could be designed to produce negative ion beams with an intensity of an order of magnitude higher than those achieved. (auth)

6300 (CEA-4735) MEASUREMENT OF PLASMA DENSITY IN A RAIL ACCELERATOR BY MEANS OF SCHLIEREN PHOTOGRAPHY. R. H. Lovberg (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 13, 1963. 43p. (CONF-363-2)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

A pulsed plasma accelerator having parallel plate electrodes was operated in a mode that produces a flat sheet of current having one-dimensional variation of field and plasma parameters over most of its area. This current layer was examined from the side with a fast double-traversal schlieren camera. Analysis of the photographs verifies a conclusion reached earlier through the use of magnetic and electric probe techniques, i.e., that the current sheet is nearly a perfect magnetic snowplow. (auth)

6301 (LAMS-2944) NUMERICAL STUDIES OF THE THETA PINCH. T. A. Oliphant, Jr. (Los Alamos Scientific Lab., N. Mex.). July 1963. Contract W-7405-eng-36. 87p.

The methods used in a fast computer program for calculating the plasma behavior in the theta pinch with the IBM-7094 are described. Sample calculations with the program, which involves Lagrangian coordinates with few mesh points, show that results obtained with 10 mesh intervals compare reasonably well with results for a more refined mesh. (D.C.W.)

6302 (LAMS-3004) SEMIANNUAL STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING OCTOBER 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Nov. 1963. Contract W-7405-eng-36. 127p.

Investigations of cyclotron radiation from a Penning discharge, enhanced light scattering by free electrons, axial and transverse magnetic field injection, mirror magnetic fields, and plasmas in Picket Fence II B and III and Scylla IV are reported. Development of associated components and apparatus is also summarized. (D.C.W.)

6303 (NP-13328) VLIYANIE PRODOL'NOGO VYSOKOCHASTOTNOGO TOKA NA STABIL'NOST SIL'NOTOCHNOGO DUGOVOGO RAZ'RYADA. (Effects of Longitudinal High Frequency Current on the Stability of High-Current Arc Discharge). Yu. G. Bobrov, P. G. Popov, and I. M. Roife (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 15p.

Stabilization by high-frequency longitudinal currents in high power arc columns was analyzed. It is shown that a high-frequency rapture at the boundary layer, producing an effect in which the plasma is screened by the imposed high-frequency field, is one of the main interferences preventing dynamic stabilization. (R.V.J.)

6304 (NP-13334) ISSLEDOVANIE VOLT-AMPERNYKH KHARAKTERISTIK I KOLEBANII TOKA V TSEPI PLAZMENNOGO TERMOELEMENTA NIZKOGO DAVLENIYA. (Studies of Volt-Ampere Characteristics and Current Oscillations in the Circuit of Low-Pressure Plasma Thermoelement). V. Ya. Karakhanov, R. Ya. Kucherov, and D. G. Tatishvili (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 12p.

Volt-ampere characteristics of plasma diodes were studied at various cesium vapor pressures, and it is shown that current oscillations appear with positive and negative cathode fields. (R.V.J.)

6305 (NP-13335) O ZAKONOMERNOSTI ISPUSKANIYA ZHESTKOGO RENTGENOVSKOGO IZLUCHENIYA USTANOVKOI "TM-2." (Regularities in Strong X-ray Emission by TM-2 Device). V. V. Matveev, A. D. Sokolov, and L. A. Suchkova (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu). 1963. 12p.

Strong x-ray emission from the toroidal Tokomak-M2 installation was investigated. Plasma yield and x-ray energy were studied as functions of electric and magnetic field intensities and initial gas pressure. The x-ray distribution was also analyzed. The effects of gas composition on x-ray emission is shown. (R.V.J.)

6306 (NP-13336) ZHELOBKOVYE VOZMUSHCHENIYA PLASMY V VINTOVAM MAGNITNOM POLE. (Flute-like Perturbation in Helical Magnetic Field). L. V. Mikhailovskaya and A. B. Mikhailovskii (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). 1963. 28p.

A kinetic method was used in an investigation of flute-like perturbations in plasma confined by a helical cylindrically symmetrical magnetic field. An equation was developed in geometric optical approximation for relating the frequency to perturbation wave vectors for arbitrary gas-magnetic pressure ratios (β) and arbitrary ratios of Larmor radii to wave lengths (ρ/λ). Stabilization criteria by finite Larmor radii were found for small β values and finite ρ/λ. Interactions of resonance particles with waves in some cases result in perturbation buildup. It was also shown that the buildup in a helical field differs from that examined by Rosenbluth et al. (Nuclear Synthesis, suppl. 1962, p.1: 143(1962)). (tr-auth)

6307 (NP-13358) O DREIFOVOI NEUSTOICHIVOSTI V PLOTNOI PLASME. (On the Dense Plasma Drift Stability). L. V. Mikhailovskaya and A. B. Mikhailovskii (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). 1963. 13p.

It is shown that the drift instability in inhomogeneous zero temperature-gradient plasma, described by B. B. Kadomtsev, et al. (Doklady Akad. Nauk 146: 581(1962)) and A. V. Mikhailoskii et al. (Zh. Eksperim. i Teor. Fiz. 44: 912(1963)), should not be present in cases in which the plasma pressure is sufficiently high in comparison to the magnetic pressure, $\beta = 8\pi p/B^2 > 0.13$. Drift instability along the plasma pressure-perturbation wavelength plain was determined. (tr-auth)

6308 (NP-13362) MEASUREMENTS AT 33 kMc/s OF DOPPLER FREQUENCY SHIFT. Rijnhuizen Report 63-09. L. Th. M. Qrnstein, C. A. J. Hugenholtz, and H. A. Van der Laan (Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Fysica, Jutphaas, Netherlands). July 1963. 7p.

Doppler frequency shift at microwave frequencies can be used to determine the velocity of a moving plasma. A reflected signal mixed with the signal of the original fre-

quency yields a changing standing wave pattern from which the velocity can be calculated. A method is described where the actual Doppler frequency shift of the reflected signal is measured by means of a frequency discriminator. From the actual shift not only the magnitude of the velocity but also the direction of motion can be deduced. (auth)

6309 (NP-13402) INTERACTION OF SOLID PARTICLES WITH AN IONIZED GAS. Technical Report ILL-12-P. S. L. Soo and R. C. Dimick (Illinois. Univ., Urbana). Nov. 1963. Project SQUID. Contracts Nonr-3623(00) and NR-098-038. 21p.

Consideration of equilibrium of ionization of a gas-solid suspension shows that the solid particles will always become positively charged if the ionization of the gaseous atoms is negligible. However, the combination of high value of thermionic potential and low value of ionization potential of the gas may leave the solid particles negatively charged. Experiments with an arc flame of argon show that addition of metals tends to increase the recombination rate while oxides tend to decrease the recombination rate of argon. (auth)

6310 (SSD-TDR-63-219) AC STABILIZED THETA-PINCH. S. L. Leonard and M. H. Dazey (Aerospace Corp., El Segundo, Calif.). Nov. 15, 1963. Contract AF04(695)-169. 35p.

An attempt is made to demonstrate the dynamic a-c stabilization of the magnetic confinement of a plasma column in a theta-pinch apparatus capable of producing 250 kA. The stabilizing current was produced by the damped oscillating discharge of a specially fabricated 115 kv capacitor. No stabilizing effect was observed. A second theta-pinch apparatus capable of producing currents of up to 400 kA has been used in further experiments. The dynamic behavior of the plasma produced in this device has been studied with the aid of streak photography, Kerr-cell photographs, and high-speed framing camera photographs. An unsuccessful attempt was made to stabilize the confinement of the plasma in this device, using the oscillatory discharge of a coaxial array of capacitors to provide the desired r-f magnetic fields. Spectroscopic studies of the plasma, including measurements of the ratio of the intensity of the D_β Balmer line to the intensity of the continuum, yielded values for the electron temperature and electron (ion) density. An account is given of attempts to develop a vacuum tube oscillator capable of producing stabilizing currents of the desired magnitude. The reasons for the abandonment of this effort are given. (auth)

6311 (SSD-TDR-63-265) EFFECTS OF COLLISIONS ON ELECTRON DENSITY FLUCTUATIONS IN PLASMAS. M. S. Grewal (Aerospace Corp., El Segundo, Calif.). Oct. 22, 1963. Contract AF04(695)-269. 46p.

The spectrum of electron density fluctuations was previously calculated for a collisionless plasma. The theory is extended to include collisions as represented by a Fokker-Planck equation such as the one used in the theory of Brownian motion. Numerical calculations were made to show graphically the transition of the spectrum from the collisionless to the collision-dominated case. The results of the analysis involve some thus far untabulated functions. These functions were numerically evaluated, and the results are presented in graphical form. (auth)

6312 (SSD-TDR-63-312) HEATING AND CONFINEMENT OF A PLASMA BY ALTERNATING MAGNETIC FIELDS. Erich S. Weibel (Aerospace Corp., El Segundo, Calif.). Nov. 20, 1963. Contract AF04(695)-169. 41p.

A method is proposed in which a plasma is confined by an alternating magnetic field. The plasma is field-free except in a thin boundary layer. No diffusion takes place since this boundary is periodically reconstituted by the field, maintaining the penetration depth at the fixed value c/ω_p. At high temperatures, the confining field very efficiently heats both electrons and ions, preferentially the latter. About half of the total applied power is absorbed by the plasma, the rest being copper losses. The technical feasibility of plasma confinement by alternating magnetic fields is examined, and numerical examples are given. (auth)

6313 FINE STRUCTURE IN CURRENT SHEATHS. Bruno Bertotti (Euratom–CNEN, Frascati, Italy). Ann. Phys. (N. Y.), 25: 271-89(Dec. 1963).

The general, exact theory of a collisionless planar current sheath is developed with the constants-of-integration method. Every quantity depends on a single space variable x alone; electric field, current, and magnetic field are mutually orthogonal. Appropriate approximation methods can be developed to investigate the structure of the deviations from charge neutrality when the Debye distance d is much smaller than the sheath thickness; they appear either as local spatial electrostatic oscillations, whose wavelength is proportional to d as $d \to 0$; or as space-charge regions whose size is comparable to the scale of the magnetic transition itself. The general criterion for the presence of such oscillations is given and the investigation of their structure is reduced to quadratures. The simple case of two monoenergetic beams turned around by a magnetic field is discussed in detail. The problem of confinement by an external magnetic field is treated in detail in the case where in the plasma the particles all move only in the x-direction with a Maxwellian distribution; there are no oscillations and the potential jump across the sheath diverges logarithmically as $d \to 0$. (auth)

6314 THE DECAY OF METASTABLE ATOMS IN A PULSED DISCHARGE IN KRYPTON. D. S. Smith and R. Turner (National Research Council, Ottawa). Can. J. Phys., 41: 1949-59(Dec. 1963). (NRC-7580)

The rate of decay of metastable krypton atoms in the $1s_5$ state was measured in the range 0.2 to 1.8 mm Hg of krypton pressure. The measured values of decay time τ can be fitted to a theoretical curve $1/\tau = 30/p + 75p + 44p^2$ (p = pressure in mm). The effects of collisions with electrons were estimated. Comparison with previous measurements of destruction frequencies in neon and argon show that the relative importance of three-body collisions is greater for krypton than for the other two gases. (auth)

6315 NOTE ON THE VLASOV EQUATION FOR PLASMAS. Ta-you Wu (National Research Council, Ottawa) and M. K. Sundaresan. Can. J. Phys., 41: 1960-6(Dec. 1963). (NRC-7579)

The linearized Vlasov equation is solved as an initial value problem by expanding (the Fourier components of) the distribution function in a series of Hermite polynomials in the momentum, with coefficients that are functions of time. The spectrum of frequencies is given by the eigenvalues of an infinite matrix. All the frequencies ω are real, extending from small values of order $\omega^2 = k^2\langle u_0^2\rangle$, where $\langle u_0^2\rangle$ is the mean square velocity of the positive ions (of mass M), to $\omega^2 \simeq \omega_1^2 + k\langle u_1^2\rangle$, where ω_1, $\langle u_1^2\rangle$ are the plasma frequency and mean square velocity of the electrons (of mass m). The classic work of Landau solves the Vlasov equation for (the Fourier transform of) the potential for which the damping is obtained, whereas the equation is solved for (the Fourier transform of) the distribution function itself. This work gives results equivalent to those of Van Kampen, but the method is simpler and in fact elementary. (auth)

6316 NONLINEAR PROPAGATION OF ELECTROMAGNETIC WAVES IN MAGNETOPLASMAS. Mahendra Singh Sodha and Carl J. Palumbo (Republic Aviation Corp., Farmingdale, N. Y.). Can. J. Phys., 41: 2155-65(Dec. 1963).

An expression for the conductivity tensor of a Lorentzian plasma in the presence of a static magnetic field, which is correct to terms involving the square of the amplitude of the electric vector is derived. This expression along with the wave equation was used to obtain a second-order solution for the electric vector in the magnetoplasma. The phenomenon of demodulation of an amplitude-modulated wave was also briefly discussed. (auth)

6317 A NOTE ON WAVE PHENOMENA DUE TO A MOVING AND OSCILLATING DIPOLE IN A COMPRESSIBLE PLASMA COLUMN. M. Yildiz and S. N. Samaddar (Raytheon Co., Wayland, Mass.). Can. J. Phys., 41: 2268-75(Dec. 1963).

The excitation of coupled electromagnetic and plasma acoustic waves by an oscillating electric dipole moving along the axis of an infinitely long cylindrical column of compressible plasma surrounded by vacuum is considered. Linearized plasma equations containing an isotropic pressure term plus an external moving dipole in Maxwell's equations are used. Although the differential equations of fields can be decomposed into the electromagnetic mode and the plasma mode, they become coupled through the boundary. (C.E.S.)

6318 HYDROMAGNETIC WAVES. Guy Boillat. Compt. Rend., 257: 3313-15(Nov. 25, 1963). (In French)

Different hydromagnetic waves can be propagated, given a particular state. One type (Alfven waves) always remain in the same type, while others (slow and fast waves) eventually generate shocks (compression waves). (tr-auth)

6319 THE CORONA PRESSURE EFFECT (Δp) AND THE THERMIONIC ANALOGUE OF THE JOSHI EFFECT $(\Delta i)_T$ IN HYDROGEN IN A SEMI-IONIZER. R. J. Galagali (Banaras Hindu Univ., India). Czech. J. Phys., 13: 692-8 (1963).

Conditions favorable for the co-occurrence of the corona pressure effect and the thermionic analog of the Joshi effect are determined and a study is made to find whether the corona pressure data can be used to interpret the mechanism of Δi. (auth)

6320 ON THE MOTION OF A PARTICLE IN A MAGNETIC TRAP WITH A SECONDARY ELECTROMAGNETIC FIELD. R. Klima (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 13: 716-24(1963).

The adiabatic approximation of motion in the plane perpendicular to the magnetic induction B and the averaged motion in the direction parallel to B are derived from the hamiltonian transformed to natural coordinates. Certain conservative properties of the field are shown. The conditions derived therefrom for magnetic traps with a cusped field are given. (auth)

6321 THE STATIONARY CONFINEMENT OF PLASMA BY A MAGNETIC FIELD AT ANISOTROPIC PRESSURE. Z. Sedláček (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 13: 725-31(1963).

The method of moments of the Boltzmann-Vlasov equation is used to derive relations between the macroscopic quantities of high-temperature plasma and the static electromagnetic field by which the plasma is stationarily confined. The well-known relation between the isotropic pressure of particles and the pressure of the magnetic field is then obtained as a special case. Plane geometric configuration of the plasma boundary and negligible collision interaction of the particles are assumed. The results are verified on a simple kinetic model of plasma with known trajectories of the particles. (auth)

6322 STATIC THEORY OF DENSITY AND POTENTIAL DISTRIBUTION IN A BEAM-GENERATED PLASMA. D. A. Dunn and S. A. Self (Stanford Univ., Calif.). J. Appl. Phys., 35: 113-22(Jan. 1964).

An electron beam passing through a gas ionizes the gas, and the electrons and ions so produced collect in the vicinity of the beam to form a plasma with a number density that can be much greater than the density of the beam. A one-dimensional static theory for such a system, with a beam either partially or completely filling the space between two parallel planes, gives the plasma density and potential distribution in the space. The theory requires only minor modifications of the Langmuir–Tonks free-fall theory of the positive column. A plasma filling the space occupied by the beam is separated by a low potential sheath from a somewhat lower density plasma that extends to the walls where a second higher potential sheath is formed. A comparison between the results of this theory and previously reported density measurements on beam-generated plasmas gives reasonable agreement. (auth)

6323 MULTIPLE PROBE MEASUREMENTS IN HIGH-FREQUENCY PLASMA LASERS. Sol Aisenberg (Raytheon Co., Waltham, Mass.). J. Appl. Phys., 35: 130-4(Jan. 1964).

A multiple probe technique is described for the accurate measurement of the retarding potential characteristics of probes in high-frequency electrodeless plasmas. Earlier multiple probe methods are discussed along with their advantages, assumptions, and limitations. The improved triple probe technique, developed for diagnostic measurements in plasma lasers, allows the complete probe characteristic to be traced rapidly. From the retarding potential characteristic for the electrons, the electron temperature and density can be determined for the low-energy electrons, together with the electron energy distribution function. (auth)

6324 INTERACTION BETWEEN PLASMA OSCILLATION AND RADIATION FIELD. [PART II.] RADIATION FROM PLASMA OSCILLATION. Kenya Matsuura (Electrotechnical Lab., Tokyo). J. Phys. Soc. Japan, 18: 1649-56(Nov. 1963).

It is shown that the radiation from plasma oscillation in a spatially homogeneous plasma is possible as the cooperative phenomena of the radiation with a stationary growing of plasma oscillation and as the emission of photons due to the mediation of the electrons forming a beam. The radiation intensities are also evaluated. (auth)

6325 MICROWAVE GENERATION OF HARMONICS IN PLASMA RESONANCE. Makoto Moriyama and Masao Sumi (Electrical Communication Lab., Tokyo). J. Phys. Soc. Japan, 18: 1656-66(Nov. 1963).

By taking account of plasma oscillations and a spatial variation of electron density and solving the nonlinear Boltzmann and the Poisson equations by the perturbation method, the harmonic components of the distribution function of electrons, the intensity of inner electric field of plasma, and the discharge current density are found in the case of plasma resonance. Then a harmonic power conversion ratio is derived and compared with experiments. The effect of the velocity dependence of collision frequency on the harmonic power is discussed. (auth)

6326 EFFECT OF COULOMB INTERACTION ON PLASMA FREQUENCY. Yukio Ôsaka (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 1687-8(Nov. 1963).

The plasmon frequency is determined. The polarization of the medium of electron gas is considered in replacing the bare Coulomb factor (Fourier component of the Coulomb interaction) by an effective interaction factor. (R.E.U.)

6327 ABSORPTION OF ELECTROMAGNETIC RADIATION BY AN ELECTRON GAS. Yukio Ôsaka (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 1689-9(Nov. 1963).

It is shown that the two individual electron excitation has larger contributions to the absorption of electromagnetic radiation than the process accompanied by plasmon emission. (R.E.U.)

6328 TEMPERATURE DEPENDENCE OF PLASMA FREQUENCY. Yukio Ôsaka (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 1689-90(Nov. 1963).

It is shown that the electron-phonon interaction in an electron gas has a shift-effect on the plasma frequency. (R.E.U.)

6329 IONIC WAVES IN A PLASMA GENERATED BY AN ELECTRON BEAM. Tomizo Itoh (Electrical Communication Lab., Tokyo). J. Phys. Soc. Japan, 18: 1695 (Nov. 1963).

Some experimental results are shown for ionic plasma waves formed by an ionizing electron beam in magnetically confined plasmas. (R.E.U.)

6330 EFFECT OF MICROWAVE POLARIZATION ON ABSORPTION BY CYLINDRICAL PLASMA. Uichi Kubo and Yoshio Inuishi (Osaka Univ.). J. Phys. Soc. Japan, 18: 1705-6(Nov. 1963).

The effects of microwave polarization were found in a certain condition of plasma during measurements of transmitted-wave attenuation and phase shift through the cylindrical plasma using a square microwave horn. (R.E.U.)

6331 OBSERVATIONS OF RADIATIONS FROM THE PLASMA IN A STATIC MAGNETIC FIELD. K. Mitani, H. Kubo, and A. Nishio (Kyoto Univ.). Kakuyoko-Kenkyu, 6: 417-41(1961). (In Japanese)

6332 DIFFUSION OF THE BEAM IN A MAGNETIZED PLASMA. T. Homma (Electrotechnical Lab., Tokyo). Kakuyoko-Kenkyu, 6: 442-56(1961). (In Japanese)

6333 INSTABILITY CRITERION FOR PLASMA OSCILLATIONS IN A MAGNETIC FIELD. Yasutomo Ozawa (Hokkaido Univ., Japan), Ikuo Kaji, and Masafumi Kito. Kakuyoko-Kenkyu, 6: 457-72(1961). (In Japanese)

A dispersion equation of the Cauchy type for longitudinal plasma oscillations in a magnetic field is derived exactly, on the basis of the Vlasov collisionless kinetic equation for an arbitrary electron distribution function $\Phi(k,v)$. The terms in Φ that are responsible for drift instabilities, and for instabilities owing to anisotropic velocity distributions, are separated. Criteria and conditions for plasma instabilities are tabulated with the help of potential theory. (T.F.H.)

6334 THE PROBLEM OF CONTROLLED THERMONUCLEAR FUSION AND EURATOM ACTIVITIES IN PLASMA PHYSICS. D. Palumbo. Neue Tech., 5: 606-20 (Oct. 1963). (In French)

The fundamental reactions, prospects, and problems in the production of controlled thermonuclear reactions are discussed. The EURATOM-sponsored program of studies in plasma physics, plasma diagnostics, and containment means (viz. mirrors, theta pinches, magnetic cusp fields, and r-f containment) are outlined. Methods for obtaining high-density plasma are noted. (T.F.H.)

6335 AXIAL CONTRACTION IN THE THETA PINCH. T. S. Green (Culham Lab., Berks, Eng.). Nucl. Fusion, 3: 57-61(June 1963).

A study was made of the axial contraction of plasma in a theta pinch, which occurs when the magnetic field trapped by the plasma is reversed in sense relative to the confining field, thus creating a closed-field-line configuration. This contraction takes the form of an apparent area shock—that is, of an increase in area—which propagates from the ends of the coil to its center. Previous studies have shown that the contraction is of this form and that the velocity is of the order predicted by a simple theory. In the present experiment the area changes were detected by measurement of the changes in flux distribution arising from them with a balanced magnetic pick-up loop system. The amplitude, velocity, and rise time of the area shocks were measured as functions of the initial trapped field at the start of the pinch. The correlations between these factors were compared with the theoretical predictions. In particular the velocity of propagation predicted by steady state theory is given by the expression $V^2 = C_u^2 \alpha y_1 (y_1 + y_0)$ where V is the velocity of propagation, C_u is a characteristic velocity, α a constant depending on tube and coil geometry, and y_1, y_0 the ratios of the area behind and ahead of the shock, respectively, to the coil area. The experimental value of C_u in a non-steady-state magnetic field was measured to be 1.05×10^8 cm/sec, compared with the theoretical value of 1.0×10^8 cm/sec calculated for constant magnetic field at its peak value. The area behind the shock was calculated under the assumption that it is of such a value as to give pressure balance at the piston. The derived expression is $y_1^2 = 2z$ where z is the ratio of the area filled with trapped field to the coil area. Combination of these two equations shows that the energy in the shock comes from the disappearance of the trapped field. Finally the results on the apparent rise time of the shock show that its value depends critically on the trapped flux. It is suggested that this may arise from the effects of reversed field loops which close within the plasma. Consequently a comparison of the data with computer calculations may lead to the derivation of information concerning the gradients of field within the plasma. (auth)

6336 AN ULTRA-FAST PINCH EXPERIMENT. J. H. Adlam and L. S. Holmes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Fusion, 3: 62-74 (June 1963).

A quartz tube 10.8 cm long, 2.8 cm in internal diameter, and 1 mm in wall thickness was used to produce the pinch effect by current in an axial direction in pre-ionized plasma. Before the gas was ionized, a magnetic field in the axial direction was produced by external coils. The following magnitudes are typical: duration of pulse, 25 mμsec; potential difference between the electrodes, 20 kv; current through the tube, 30 ka; gas pressure before ionization 50 mtorr. Measurements were made of the potential difference between the electrodes, the current through the tube and the magnetic field within the tube in both the θ and z directions. It was found that the current skin thickness (3 to 4 mm) was much larger than any existing theory predicts. A theory based on the assumption that the drift velocity of the electrons is limited by "streaming" instabilities is developed. This theory explains most although not all of the experimental results. (auth)

6337 STABILITY OF A ROTATING PLASMA WITH ANISOTROPIC PRESSURE. J. N. Tandon and S. P Talwar (Univ. of Delhi). Nucl. Fusion, 3: 75-7(June 1963).

An investigation was made of the hydromagnetic stability of an infinitely extended, uniformly rotating configuration

of dilute plasma subjected to the influence of a strong homogeneous magnetic field. These assumptions lead to a plasma pressure of tensorial nature. The effect of self-gravitation of the medium was also incorporated in view of its astrophysical significance. It is shown that the system is, in general, unstable. Criteria of instability in terms of pressures, parallel and perpendicular to the magnetic field, are derived for the following special cases: (a) $k_\perp = 0$, (b) $k_{||} = 0$, (c) $k_{||} \to 0$, $\omega \to 0$. $k_{||}$ and $k_\perp$ denote the propagation vectors parallel and perpendicular to the magnetic-field vector. An analogue of Jeans's condition for the fragmentation of interstellar clouds with anisotropic pressure is obtained, and it is found that the fragmentation along the magnetic-field lines is possible only if $p_{||} < p_\perp + H^2/4\pi$. (auth)

6338 SOME MAGNETIC-PROBE MEASUREMENTS ON A THETA-TYPE GAS DISCHARGE. W. A. Cilliers, H. S. Driver, J. Irving, and I. Lewin (Univ. of Cape Town). Nucl. Fusion, 3: 78-83(June 1963).

Various magnetic-probe measurements were carried out to investigate the behavior of the plasma in a theta-type discharge. With "balanced" probes, the amount of trapped field at the second implosion could be estimated. This technique was also used to estimate the electron temperature and the velocity of the imploding current sheath. (auth)

6339 FLIP INSTABILITY OF PLASMA IN THE THETA PINCH. C. Bartoli and T. S. Green (Euratom-CNEN, Frascati, Italy). Nucl. Fusion, 3: 84-8(June 1963).

Recent experiments on the behavior of plasma in the theta pinch have shown that, although the plasma in reversed-field discharges is normally unstable, there are some cases in which the plasma is stable and contained. The present paper considers the following hypothesis: (a) that the mode of instability commonly encountered is that observed by Clark and Wuerker (in which the axis of the magnetic moment of the current supporting the trapped reversed field appears to rotate from its initial state of alignment with the field axis) and (b) that there exists a class of configurations of the plasma enclosed by the field lines that are stable against this rotation of the plasma axis. This class of configurations is characterized by a high length-to-radius ratio and by having both radial and axial pressure balance. Under these conditions the trapped field acts only to determine the plasma area and does not contribute significantly to the total energy of the system. Rotation of the plasma axis then leads to an increase of the total energy of the system, so that the plasma is stable. It is shown that the few observations of stability are consistent with plasma configurations of this type. (auth)

6340 ON A REPRESENTATION OF TOROIDAL SURFACES. APPLICATIONS TO MAGNETOHYDRODYNAMIC EQUILIBRIA. Claude Mercier (Euratom-CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 3: 89-98(June 1963). (In French)

By a study of the representation of a class of toroidal surfaces, the following problem can be solved for plasmas of small diameter: Given a toroidal surface, what are the magnetohydrodynamic (MHD) equilibria which have this surface as a magnetic surface (or constant-pressure surface)? The solution of this problem gives a physical interpretation of the quantities involved in the local stability criterion developed in the neighborhood of the magnetic axis and yields a qualitative understanding of what happens when a toroidal MHD system is such that its angle of rotational transformation on the magnetic axis ι_{c0} is in the neighborhood of $2k\pi$ where k is a whole number. A study of the MHD equations in the neighborhood of a magnetic axis shows that, in general, equilibrium is not possible for $\iota_{c0}/2\pi = k$. If $\iota_{c0}/2\pi$ approaches k, it is shown that the magnetic axis moves toward the external surface and tends towards a helix form turning around the central axis of the configuration with a pitch equal to L/k. It could be postulated as a condition for the existence of such states that the magnetic axis does not move too far from the center of the configuration. This requirement limits the stability zones which a study of the local stability criterion produces for values of $\iota_{c0}/2\pi \geq k$. Finally, a fairly strict limitation of the quantity $\beta = 2p/B^2$ is obtained at least in cases where $k \neq 0$. The calculations are developed for the case of a plane magnetic axis ($1/T(s) = 0$) defined by $1/R(s) = a_0 + 2a_k \cos 2k\pi s/L$. This intrinsic equation represents a closed curve of length $L = 2\pi/a_0$ irrespective of what a_k may be if k is even. (auth)

6341 BRANCHING EQUILIBRIA AND HYDROMAGNETIC STABILITY. G. Laval, R. Pellat, and P. H. Rebut (Euratom-CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 3: 99-112(June 1963). (In French)

The branching equilibria of a family of hydromagnetic equilibria are defined and studied. It is shown that if the laws of motion satisfy certain very general conditions, the results of this study permit the formulation of a criterion necessary for stability. A formalism independent of geometry is introduced and a variation principle is found from which the equilibrium equations are derived. The method proposed is used to study the stability of plane, cylindrical, and rotational equilibria, and the results are compared with those obtained with explicit laws of motion. In cases of tubular configurations, a stricter criterion is obtained than that derived from classical magnetohydrodynamics since new possibilities of instability are taken into account corresponding to changes in topology of the magnetic surfaces. (auth)

6342 KINETIC METHOD OF INVESTIGATING OSCILLATIONS AND STABILITY OF INHOMOGENEOUS PLASMA IN A HELICAL MAGNETIC FIELD. L. V. Mikhailovskaya and A. B. Mikhailovskii (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 3: 113-23(June 1963). (In Russian)

A new method based on the use of the kinetic Vlasov equation is suggested to investigate oscillations and stability of inhomogeneous plasma in a helical magnetic field of cylindrical symmetry. A dielectric permeability tensor was obtained for the plasma configuration mentioned. Exceeding the limits of hydrodynamics permits one to study oscillations with a wavelength of the order of the Larmor radius of the particles. In addition such an approach makes it possible to take into consideration interaction between the resonance particles and the wave thus permitting investigations of the "kinetic" mechanisms of oscillation buildup. These questions have also been discussed in an earlier article. The advance that is achieved in the present work consists of consideration of the curvature and shear of the magnetic field lines. With consideration of these quantities, equations were obtained that make it possible to investigate the behavior of drift waves that are unstable in the case of a magnetic field with straight and parallel lines, and also waves that have been discussed by Suydam. The effect of a buildup of convective perturbations with resonance electrons that is connected with their motion along the lines of force is discussed. Such an effect takes place when the hydrodynamic instability of Suydam is stabilized because of the large Larmor radius of the ions. The buildup effect mentioned is analogous to the "residual-instability" effect but considerably stronger than the latter

if plasma pressure is small compared to magnetic pressure. This effect exists if there is a temperature gradient. It is shown that in a plasma that is in a gravitational field and confined by a straight magnetic field, an analogous effect of drift buildup of flute perturbations is possible. (auth)

6343 PRODUCTION OF A STABLE HIGH-TEMPERATURE PLASMA IN AN ADIABATIC TRAP WITH A COMBINED MAGNETIC FIELD. E. I. Kuznetsov (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 3: 126-7 (June 1963). (In Russian)

Several years ago Soviet scientists including Academician L. A. Artsimovich, B. B. Kadomtsev and M. S. Ioffe, suggested magnetic traps with fields of combined types in which the field strength increases in all directions from the region occupied by plasma, and does not vanish anywhere. Their purpose was to avoid simultaneously the flute instabilities that occur in mirror traps and the anticipated leakage from variation of magnetic moments at regions of zero field. As reported at the 1961 Salzburg conference (Nuclear Fusion, 1962 Supplement, Part 3, 1045), stabilizing windings added to a mirror trap increased the plasma lifetime from 100 to 500 μsec and to a value that was assumed to be limited by the rate of ion charge exchange. Because of imperfect vacuum conditions in the device, this last conclusion could not be made with sufficient certainty. In 1962 a new device of the same kind, called "PR-5," was made with more perfect vacuum conditions. It has a longitudinal field of 5 kOe, mirror ratio of 1.7, a stabilizing field at the wall of 4.5 kOe, 5×10^{-8} torr in the center with a steady hydrogen inlet to the plasma source, and a current half life of 55 msec in the stabilizing windings. A plasma density of 10^9 to 10^{10} cm^{-3} was obtained with an ion temperature of about 5 kev and an electron temperature of about 20 ev. The stabilizing windings are most effective. Lifetime increased to 3.5 msec at 1.5×10^{-7} torr (compared with 0.5 msec in the old device) and reached 15 to 30 msec at lower pressures. The Langmuir probe shows that deep plasma density pulsations disappear completely as the stabilizing field increases. The new data show that for beta about 10^{-3} the trap ensures stable confinement undisturbed by magnetohydrodynamic instabilities. (auth)

6344 PROTON TRAPPING IN DCX-1 FROM LORENTZ DISSOCIATION OF H_2^+. Herman Postma, G. R. Haste, and J. L. Dunlap (Oak Ridge National Lab., Tenn.). Nucl. Fusion, 3: 128-9(June 1963).

Experiments were conducted in the DCX-1 to investigate various means of ion production in order to optimize the population of the desired excited states, and to determine whether proton trapping from Lorentz dissociation would be an effective mechanism for building up plasma densities. Lorentz trapping could not be detected in H_2^+ taken directly from the duoplasmatron, but Lorentz trapping fractions of 5×10^{-6} to 10^{-4} were observed for H_2^+ formed from the dissociation of H_3^+ in a water vapor cell. (D.L.C.)

6345 BREMSSTRAHLUNG RADIATION FROM RELATIVISTIC PLASMAS. B. Buti (Univ. of Delhi). Phys. Letters, 7: 191-2(Nov. 15, 1963).

It is shown that radiation emitted as bremsstrahlung from hot plasmas asymptotically behaves as T ln T, where T is the equilibrium temperature of the plasma, whereas in the nonrelativistic limit the $T^{1/2}$ dependence holds. (C.E.S.)

6346 INVESTIGATIONS ON MOVING STRIATIONS BY MEANS OF PERIODICALLY PULSED IMAGE CONVERTER. B. Saggau (Technische Hochschule, Stuttgart). Phys. Letters, 7: 196-7(Nov. 15, 1963).

A pulsed image converted is presented for the optical investigation of moving striations in the positive column of a gas discharge. The device works for frequencies up to 1 Mc. The shortest time of the exposure pulse is 0.1 μsec. (C.E.S.)

6347 SPIN EFFECTS ON THE PLASMA OSCILLATIONS OF AN ELECTRON GAS IN A MAGNETIC FIELD. S. Gartenhaus and G. Stranahan (Purdue Univ., Lafayette, Ind.). Phys. Rev., 133: A104-6(Jan. 6, 1964).

A dispersion relation, which includes the effects of spin, for the longitudinal oscillations of an electronic plasma in a magnetic field is calculated. In the long-wavelength and low-temperature limit, explicit formulas for the frequencies are obtained, and it is suggested that the result may be useful for the experimental determination of the product of the electronic g factor and the effective mass. (auth)

6348 STABLE LONGITUDINAL OSCILLATIONS IN ANISOTROPIC PLASMA. [PART] II. Terry Kammash and Warren Heckrotte (Univ. of California, Livermore) Phys. Rev., 133: A132-4(Jan. 6, 1964). (UCRL-7730 (Pt.II))

The dispersion equation for longitudinal oscillations in an infinite collisionless anisotropic plasma in a uniform magnetic field is investigated. It is shown that nonoscillating, exponentially growing modes cannot exist in a plasma whose equilibrium distribution function is a two-temperature Maxwellian. This is demonstrated by showing that the dispersion equation has no solution under these conditions. The Nyquist criterion for plasma instability is also invoked to prove that all longitudinal modes propagating along the magnetic field in such a plasma are stable. (auth)

6349 GROUND-STATE ENERGY OF A HIGH-DENSITY ELECTRON GAS. W. J. Carr, Jr. and A. A. Maradudin (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 133: A371-4(Jan. 20, 1964).

The terms of $O(r_s \ln r_s)$ and $O(r_s)$ in the expansion of the ground-state energy of the high-density electron gas are studied. The value of the coefficient of $r_s \ln r_s$ is evaluated, and it is found to differ from the values obtained by DuBois. The result for the energy per electron is $E = 2.21 r_s^{-2} - 0.916 r_s^{-1} + 0.0622 \ln r_s - 0.096 + 0.018 r_s \ln r_s + (E_3' - 0.036) r_s + O(r_s^2 \ln r_s)$, where E_3' is a sum of twelve dimensional integrals. Although E_3' was not evaluated it is shown with the aid of the virial theorem that no reasonable value of E_3' can make the series expansion rapidly convergent beyond $r_s \sim 1$. Under the rather arbitrary assumption that $E_3' r_s$ as well as higher order terms can be neglected below $r_s = 1$, an interpolation between this result and the low-density expansion is carried out, and values of the correlation energy in the region of metallic densities are estimated. (auth)

6350 EQUILIBRIUM PROPERTIES AND EQUATION OF STATE OF A HYDROGEN PLASMA. Gilda M. Harris (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 133: A427-35(Jan. 20, 1964).

Equations are developed for the equilibrium composition and thermodynamic properties of a three-component hydrogen plasma. These are based on a formulation of the total Helmholtz free energy for the system, including corrections to ideal gas behavior due to electrostatic interactions and plasma perturbation of the bound electronic states of hydrogen atom. When a shielded Coulomb potential is used for the perturbation of the bound states and a Debye approximation for the collective electrostatic interactions, it turns out that for low-density, low-temperature plasmas, the bound-state correction, which was largely ignored, is much more important than the electrostatic correction. The results of a specific calculation based on this model

are analyzed and compared with indirect hydrogen plasma temperature-density measurements and with other theoretical calculations based on different approximate free-energy formulations. (auth)

6351 LANDAU DAMPING OF ION ACOUSTIC WAVES IN HIGHLY IONIZED PLASMAS. A. Y. Wong, R. W. Motley, and N. D'Angelo (Princeton Univ., N. J.). Phys. Rev., 133: A436-42(Jan. 20, 1964). (MATT-177)

Ion acoustic waves with frequencies between 5 and 100 kc were excited in highly ionized cesium and potassium plasmas by modulating the potential of a tungsten grid immersed in the plasma. The waves were detected by another grid, which could be moved along the plasma column. Because the plasma is produced at one end of the column, there is a net flow of plasma between the grids. Phase velocities of 1.3×10^5 and 0.9×10^5 cm/sec along and against this drift were measured for cesium and 2.5×10^5 and 1.3×10^5 cm/sec for potassium. The damping distance of the waves was found to be independent of ion density in the range between 2×10^{10} and 3×10^{11} cm^{-3} and equal to 0.55 and 0.25 wavelength along and against the flow in cesium and 0.65 and 0.14 in potassium. A comparison between the results and the collisionless theory shows agreement within about 10%. In particular, it is shown how the present experiment provides a quantitative measurement of the Landau damping of ion acoustic waves. (auth)

6352 METHOD FOR MEASURING THE ENERGY AND MASS SPECTRA OF THE IONIC COMPONENTS OF A MOVING PLASMA. A. A. Kalmykov, A. D. Timofeev, Yu. I. Pankratev, V. I. Tereshin, V. L. Vereshchagin, and L. A. Zlatopolskii (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekhn. Eksperim., No. 5, 142-5(Sept.-Oct. 1963). (In Russian)

A method is proposed for analyzing the ionic components of a moving plasma with respect to mass and energy. An electrostatic probe and a time-of-flight mass spectrometer are used in the analysis. It is possible to determine the mass and energy spectra over the entire length of the plasma at various time intervals or continuously during the plasma motion. (tr-auth)

6353 HARMONIC AND ANHARMONIC OSCILLATIONS OF A CYLINDRICAL PLASMA IN THE PRESENCE OF A UNIFORM AXIAL MAGNETIC FIELD AND A STEADY AXIAL CURRENT. C. Devanathan and C. Uberoi (Indian Inst. of Science, Bangalore, India). Proc. Indian Acad. Sci., Sect. A, 58: 244-56(Oct. 1963).

The harmonic and anharmonic oscillations of cylindrical plasma were investigated by means of Lagrangian formalism. In order to study the harmonic oscillations, the equations are linearized and the resulting equation for the displacement was numerically solved. For situations present in thermonuclear reactors, the presence of axial magnetic field is found necessary to make the periods of oscillation become comparable with the time required for the thermonuclear reactions to set in. A detailed analysis of the anharmonic oscillations reveals that the significant interaction is between the first and the second mode. The fundamental period of anharmonic oscillation is more than the corresponding period of harmonic oscillations by 9.2%. Graphs were drawn for the amplitudes of relative variations in density and magnetic field and of the time-varying part of anharmonic oscillation. (auth)

6354 INFRARED EMISSION FROM THE THETA PINCH. M. F. Kimmitt (Royal Radar Establishment, Malvern, Worcs., Eng.).and G. B. F. Niblett. Proc. Phys. Soc. (London), 82: 938-46(Dec. 1, 1963). (CLM-P26)

Time-resolved measurements of infrared emission from deuterium plasma in the theta pinch were made at wavelengths between 70 and 250 micrometers using an indium antimonide photoconductive detector. At long wavelengths there is a sharp drop in emission near peak compression and this is attributed to an increase of the critical plasma frequency beyond that corresponding to the wavelength of observation. Thus the effect affords a means of determining the electron density. For plasma whose dimensions and impurity content are known, the absolute measurement of the radiation at short wavelengths leads to an estimate of the electron temperature, but as the emission depends only weakly on temperature the method is not of great precision. Experimental values of density and temperature show reasonable agreement with those predicted by numerical solution of the one-dimensional two-fluid hydromagnetic equations, though the comparison suggests axial loss of plasma in the practical case. The measured electron temperature is in excess of 10^6 °K for both trapped parallel and trapped reversed magnetic field. Bremsstrahlung from impurities makes an important contribution to the radiation from reversed field discharges and appropriate allowance for this increases the estimated temperature. (auth)

6355 ELECTRON CONCENTRATIONS IN THE CATHODE REGION OF LOW VOLTAGE ARC DISCHARGES. R. C. G. Leckey, A. G. Coulter, G. S. Higginson, and T. G. Webb (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 82: 947-53(Dec. 1, 1963).

The number distribution of fast and slow electrons in the cathode region of low voltage arc discharges was calculated on the basis of diffusion theory. The results agree well with measurements obtained in hydrogen by a dynamic probe technique. A winging effect was found that may be connected with the production of electron oscillations in the plasma. (auth)

6356 ADIABATIC CHARGED-PARTICLE MOTION. Theodore G. Northrop (Univ. of California, Berkeley). Rev. Geophys., 1: 283-304(Aug. 1963). (UCRL-10750)

The adiabatic theory of charged-particle motion is developed systematically. The essentials of the theory are presented without analysis in detail. The general expressions for guiding-center motion and particle energy change are given, with application to the Van Allen radiation and to Fermi acceleration. It si shown that Fermi acceleration and betatron should not be regarded as distinct processes. Modifications of the nonrelativistic theory that are necessary when the particle is relativistic are discussed. Proofs are given of the invariance to lowest order of the first and second adiabatic invariants for the case of static fields. Applications are made to the theory of plasmas. (auth)

6357 MEASUREMENT OF ELECTRON DENSITY IN A TRANSIENT PLASMA BY MICROWAVE FREE SPACE METHOD. Syoichi Miyoshi and Yuichi Sakamoto. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 57: 111-15(Sept. 1963).

A method to improve the accuracy of measurement of electron density in a transient plasma with the microwave interferometer, by making a correction with respect to attenuation of the wave due to the plasma, is described. Experiments were also performed to measure the electron density in a transient linear plasma with the 8 mm microwave interferometer. (auth)

6358 ELECTRON PRESSURE AND INTENSITY RATIO OF SPECTRAL LINES AS A FUNCTION OF DIRECT-CURRENT ARC TEMPERATURE. C. Berthelot (Euratom, Geel, Belg.). Spectrochim. Acta, 19: 1323-34(1963). (EUR 443.f). (In French)

The line intensity ratio (λMII/λMI) of Be, Mg, Ca, Ti, V,

Cr, Mn, Mo, and Eu changes with the d-c-arc temperature (C, CuO, Li_2CO_3, and KCl matrices). The relation between the electron pressure and the temperature is log P_e(atm) = -(27,255/T) + (5/2) log T − 8.50 and the number of electrons present in the plasma is $N_e(cm^{-3}) = 2.32 \times 10^{13} T^{3/2} \exp - 5.40 (ev)/kT$. Temperature and electron pressure in the plasma and in the different layers of the sun can be determined by this method. (auth)

6359 THERMAL INSTABILITY OF PLASMA COLUMNS. G. Ecker, W. Kroell, and O. Zoeller (Universität, Bochum, Ger.). Z. Naturforsch., 18a: 1138-9(Oct. 1963). (In German)

An m = O-mode instability in a plasma column was analyzed and designated as thermal instability. Its mechanism is based on a coupling between density and temperature. Criteria were developed for the appearance of the thermal instability. (M.C.G.)

6360 ACCELERATION OF IONS IN PLASMA BEAMS. M. V. Nezlin and A. M. Solntsev. Zh. Eksperim. i Teor. Fiz., 45: 840-9(Oct. 1963). (In Russian)

Acceleration of ions in a plasma column located in a strong longitudinal magnetic field and permeated by an intense beam of fast electrons is investigated experimentally. It is found that ion acceleration is due to instability of the intense electron beam in the plasma with respect to virtual cathode formation. It is shown that the phenomenon can be employed for filling up magnetic mirror traps with a hydrogen plasma in which the ions have an energy of the order of 1 to 2 kev. (auth)

6361 INSTABILITY OF ONE-DIMENSIONAL PACKETS AND ABSORPTION OF ELECTROMAGNETIC WAVES IN A PLASMA. A. A. Andronov and V. Yu. Trakhtengerts (Gorky State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 45: 1009-15(Oct. 1963). (In Russian)

It is shown that when an energetic packet of electromagnetic waves moves in a magneto-active plasma, such conditions may arise that the plateau on the distribution function formed by the packet may be unstable. Transfer of electromagnetic energy to growing waves is considered. It is found that the energy of the initial packet changes into energy of the growing waves as well as into energy of the plasma. The nonlinear attenuation decrement for a weakly nonunidimensional electromagnetic wave packet is estimated. (auth)

6362 CONTRIBUTION TO THE THEORY OF A WEAKLY INHOMOGENEOUS PLASMA. V. P. Selin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1060-6(Oct. 1963). (In Russian)

Proper oscillations of a plasma, which is weakly inhomogeneous in three dimensions, are studied in the geometric optics approximation. The corresponding dispersion relations are derived from multidimensional quantization rules. High frequency longitudial and transverse oscillations of an electron plasma, low frequency ion-acoustic oscillations of a quasiisotropic electron-ion plasma, and low frequency oscillations of a cold magnetoactive plasma are considered by applying the dispersion relations. (auth)

6363 THEORY OF HIGH-FREQUENCY HEATING OF PLASMA. K. N. Stepanov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 1196-1201(Oct. 1963). (In Russian)

Heating of a plasma by the high frequency field of a traveling wave with a phase velocity of the order of the mean thermal ion velocity is considered. An expression is derived for the energy acquired by an ion per unit time. For a strongly nonisothermal plasma, heating of an ion gas becomes especially effective under conditions of acoustic resonance when the phase velocity of the wave is close to the velocity of sound. (auth)

6364 TURBULENT DIFFUSION OF A RAREFIED PLASMA IN A STRONG MAGNETIC FIELD. B. B. Kadomtsev. Zh. Eksperim. i Teor. Fiz., 45: 1230-42 (Oct. 1963). (In Russian)

Turbulent diffusion of a collisionless plasma in a strong magnetic field, which develops as a result of drift instability, is considered. It is shown that in the presence of oscillations, besides Landau linear damping, a nonlinear damping occurs that strongly diminishes the amplitude of the stationary oscillations. The oscillation spectrum and diffusion turbulence coefficient are approximately determined. (auth)

6365 NONLINEAR EFFECTS IN PLASMA RESONANCE. A. V. Gurevich and L. P. Pitaevskii (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 45: 1243-51(Oct. 1963). (In Russian)

Penetration of a longitudinal field, with a frequency close to the Langmuir frequency, into a plasma is examined by taking into account nonlinear effects. It is demonstrated that hysteresis of the field amplitude in the plasma occurs, that is, two values of the field in the plasma may correspond to a single value of the field strength at the boundary. An equation defining the field distribution in the plasma is obtained which resembles the Ginzburg–Landau equation in superconductivity theory. (auth)

6366 EXPERIMENTAL OBSERVATION OF LANDAU DAMPING IN PLASMA. V. V. Dolgopolov, A. I. Ermakov, Ni. I. Nazarov, K. N. Stepanov, and V. T. Tolok (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 45: 1260-1(Oct. 1963). (In Russian)

In high-temperature rarefied plasma collisionless damping may exceed the damping induced by electron-ion collisions. Experiments were conducted on collisionless wave damping that exceeds collision damping by order of two. The plasma was produced in a 60-mm glass tube by a high-frequency current passing through an excitation coil with four sections distributed in front of each other and creating a spatial periodic magnetic field. Electron temperatures, measured in relation to the He 4921 and 4713 Å lines, were ~30 to 50 ev. Collision damping expansion was $\sim 10^4$ cm, which exceeded by 200 fold the measured collisionless damping of 40 cm. The length of the collisionless damping mechanism, calculated as ~100 cm, is in agreement with experimental data. (R.V.J.)

6367 INVESTIGATION OF TRANSVERSE (HALL) DIFFUSION IN A PLASMA OF INERT GASES. V. L. Granovskii and E. I. Urazakov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1285-93(Nov. 1963). (In Russian)

Transverse diffusion of ions and electrons in a positive column in a homogeneous longitudinal magnetic field is investigated. The velocities and Hall diffusion coefficients of charged particles in helium, neon, and argon are determined as functions of the magnetic field strength, current through the plasma, neutral gas pressure, and nature of the gas, the probe technique being employed for this purpose. A comparison of the experimental facts with the theory indicates that as a whole the results obtained are in accordance with the theory of diffusion involving pair collisions with neutral molecules. (auth)

6368 INSTABILITY OF A PLASMA IN A MAGNETIC FIELD UPON TRANSITION FROM LOW TO HIGH PRES-

SURES. A. R. Akhmedov and A. A. Zaitsev (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 45: 1414-15(Nov. 1963). (In Russian)

Results of investigation of spiral instability of a positive column in a magnetic field are presented. The gas (Ne and He) pressure was as high as 40 mm Hg in the experiments. A gradual transition from instability at low pressure to instability at high pressure was observed. At pressures above 10 mm Hg the critical magnetic field for appearance of instability decreases with increase of the discharge current. (auth)

6369 NEGATIVE ABSORPTION IN A NONEQUILIBRIUM HYDROGEN PLASMA. L. I. Gudzenko and L. A. Shelepin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1445-9(Nov. 1963). (In Russian)

Conditions are examined for which a nonequilibrium hydrogen plasma may be regarded as a medium with negative absorption sufficient for creation of a generator near frequencies of ionization of hydrogen from the ground or low-lying excited levels. (auth)

6370 NONLINEAR OSCILLATIONS AND SOME EFFECTS DUE TO A LONGITUDINAL CURRENT IN A PLASMA. V. I. Petviashvili. Zh. Eksperim. i Teor. Fiz., 45: 1467-72(Nov. 1963). (In Russian)

Stationary nonlinear oscillations due to cyclotron instability of a plasma with a longitudinal current are considered. The spectrum of the oscillations is investigated and it is shown that the oscillations produce an additional resistance and heating of ions. (auth)

6371 PARAMETRIC GENERATION OF ELECTROMAGNETIC WAVES IN A MAGNETOACTIVE PLASMA. L. A. Ostrovskii and N. S. Stepanov (Gorky State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 45: 1473-8(Nov. 1963). (In Russian)

Nonlinear interaction of weak electromagnetic waves with a plasma wave in a magnetoactive plasma at rest is considered. It is shown that under certain conditions a plasma wave propagating along a magnetic field may be unstable and excite electromagnetic waves. (auth)

6372 TRANSPORT PHENOMENA IN A PLASMA IN A STRONG MAGNETIC FIELD. Yu. M. Aliev and A. R. Shister (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 45: 1499-1508(Nov. 1963). (In Russian)

Expressions for particle and heat fluxes in a plasma perpendicular to a magnetic field are obtained on basis of a kinetic equation in which the effect of the magnetic field on particle collisions are taken into account. In the case of strong magnetic fields the expressions significantly differ from those for the fluxes that the usual theory yields. (auth)

6373 DRIFT INSTABILITY OF A DENSE PLASMA. L. V. Mikhailovskaya and A. B. Mikhailovskii. Zh. Eksperim. i Teor. Fiz., 45: 1566-71(Nov. 1963). (In Russian)

It is shown that the drift instability of an inhomogeneous plasma with zero temperature gradient previously indicated should not arise if the plasma pressure is not too small compared with the magnetic pressure, $\beta = 8\pi p/B^2 > 0.13$. The limits for drift instability of a plasma in the plasma density–disturbance wave length plane is determined. (auth)

6374 QUASILINEAR THEORY OF INSTABILITY OF A PLASMA WITH AN ANISOTROPIC ION VELOCITY DISTRIBUTION. V. D. Shapiro and V. I. Shevchenko. Zh. Eksperim. i Teor. Fiz., 45: 1612-24(Nov. 1963). (In Russian)

Equations are obtained that define the change of the longitudinal and transverse ion thermal energies and also the energy of an electromagnetic field in an instability due to anisotropy of the distribution function. Conditions of applicability of the equations are obtained that reduce to the requirement of smallness of deviation of the initial plasma parameters from the critical values at which instability sets in. The equations are employed for determining the state that the plasma finally acquires as a result of development of the instability. (auth)

6375 CONIC INDUCTION SOURCE OF PLASMA CLUSTERS. Yu. S. Azovskii, I. T. Guzhovskii, Yu. P. Mazalov, V. V. Mank, B. G. Safronov, and V. A. Churaev. Zh. Tekhn. Fiz., 33: 1149-58(Oct. 1963). (In Russian)

Studies were made of a single-coil conic induction source. Plasma clusters propagating at 3×10^7 cm/sec with particle densities over 10^{14} cm^{-3} were developed, and their mass was determined. (R.V.J.)

6376 INTERACTIONS OF PLASMA CLUSTERS WITH AXIALLY-SYMMETRIC MAGNETIC FIELD. K. D. Sinel'nikov, Yu. S. Azovskii, I. T. Guzhovskii, V. E. Panchenko, and B. G. Safronov. Zh. Tekhn. Fiz., 33: 1159-68(Oct. 1963). (In Russian)

Injection of a plasma cluster into an axially-symmetric magnetic field, followed by propagation in a homogeneous field, was investigated. Observations of cluster propagation in heterogeneous field revealed considerable current induction that drops rapidly with passage into the homogeneous field. Studies were also made of charged particle diffusions across magnetic lines during cluster propagation in a homogeneous field. (R.V.J.)

6377 A DEVICE FOR PLASMA PREPARATION AND INVESTIGATION. A. E. Sheindlin, E. I. Asinovskii, V. A. Baturin, and V. M. Batenin (Moscow Research Inst. of High-Temperature). Zh. Tekhn. Fiz., 33: 1169-72(Oct. 1963). (In Russian)

Descriptions are given of an electric arc stabilized by cooled copper walls. Data are given on arc performance with argon, and it is shown that at currents of 50 to 60 amp the axial temperature is 11000 to 12000°K. (R.V.J.)

6378 MAXWELL PLASMA STABILITY. F. G. Bakshi. Zh. Tekhn. Fiz., 33: 1173-86(Oct. 1963). (In Russian)

Characteristics of electron-ion plasma instability were investigated, and electron and ion distribution functions were approximated by Maxwell functions. Dispersion relations were graphically resolved, and it is shown that with identical electron-ion fluxes the instability is convective and fluctuation potentials are dampened at the time and place of their origin. A solution was found for the case in which the electron temperature exceeds the ion temperature and particle drift velocities are smaller than thermal velocities. (tr-auth)

6379 STABILIZATION OF CYLINDRICAL PLASMA BY HIGH FREQUENCY MAGNETIC FIELD. N. A. Bobyrev and O. I. Fedyanin. Zh. Tekhn. Fiz., 33: 1187-92(Oct. 1963). (In Russian)

A stability criterion was developed for an ideal conductor with high-frequency current in a longitudinal magnetic field. Generalized equations were developed for determining the stable conditions for cylindrical, gaseous conductors in high-frequency quasi-stationary fields. (R.V.J.)

6380 RECOMBINATION EMISSION IN DIFFUSION PLASMA DECAY IN MAGNETIC FIELD. L. A. Khorassanov. Zh. Tekhn. Fiz., 33: 1193-5(Oct. 1963). (In Russian)

Plasma discharge decay determined by diffusion resulting from Coulomb pair collisions was analyzed. An attempt was made to show that plasma diffusion coefficients in

magnetic fields, previously determined by microwave measurements, can be found by the recombination emission intensity. (R.V.J.)

6381 HIGH-FREQUENCY FIELD ENERGY ABSORPTION BY PLASMA UNDER CONDITIONS OF MULTIPLE ION GYRORESONANCE. V. V. Dolgopolov and K. N. Stepanov. Zh. Tekhn. Fiz., 33: 1196-9(Oct. 1963). (In Russian)

Plasma absorption of high-frequency field energy produced by azimuthal currents flowing in a coil wrapped around a plasma cylinder was studied under conditions of multiple ion gyroresonances $\omega \simeq S\omega_i$ (where ω is wave frequency, S = 2, 3, ...). It was found that heating of high density plasma at $\omega = 2\omega_i$ is more efficient than at $\omega = \omega_i$. (tr-auth)

6382 BOUNDARY STABILITY OF DRIFT WAVES IN HETEROGENEOUS PLASMA. L. V. Mikhailovskaya and A. B. Mikhailovskii. Zh. Tekhn. Fiz., 33: 1200-5(Oct. 1963). (In Russian)

Drift wave stability criteria were investigated at arbitrary temperature and density gradient ratios. The stability maximum was found using dispersion equations for slow waves with less than Alfven velocity. Diagrams were constructed for plasma stability at various $\tau = \partial \ln T/\partial \ln n$, paramagnetic function $\sigma_{max} = \sigma_{max}(\tau)$ for $z \gg 1$, and for the effective transverse plasma heterogeneity as a function of the shortest instability wave. It is shown that longitudinal waves of unstable perturbation are much longer than the transverse heterogeneity at any arbitrary ratio $|\nabla T|$ and $|\nabla n|$. (R.V.J.)

6383 VOLT-AMPERE CHARACTERISTICS OF A HOMOPOLAR MACHINE. E. M. Drobyshevskii (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 1210-13(Oct. 1963). (In Russian)

Volt-amp characteristics of a homopolar machine containing partially ionized plasma, previously described by Alfven and Fahleson, were analyzed by an expanded theory of a positive column in a transverse magnetic field. (R.V.J.)

6384 ON KNUDSEN'S PLASMA INSTABILITIES. L. E. Rikenglaz. Zh. Tekhn. Fiz., 33: 1214-21(Oct. 1963). (In Russian)

The Landau dispersion equation was used in studies of Knudsen plasma instabilities in which ion and electron distribution functions are described by $f_{\pm}(v) = A_{\pm} \exp(-mv^2/2T)$, $v_x \geq v_{\pm}$ and $f_{\pm} = 0$ at $v_x \leq v_{\pm}$. (tr-auth)

6385 SUPER HIGH FREQUENCY PULSE DISCHARGE IN LONG TUBES. P. S. Bulkin, V. N. Ponomarev, and G. S. Solntsev (Moscow State Univ.). Zh. Tekhn. Fiz., 33: 1222-6(Oct. 1963). (In Russian)

Results are given from experiments carried out with 9470 Mc discharges in hydrogen in long tubes. There are two high frequency discharge stages, a normal and an abnormal running discharge. The normal discharge is developed instantaneously along the length of the tube, and in the case of a waveguide with plasma, the wave expands. Anomalous high-frequency discharge expands in the direction of the super-high frequency wave at a rate of 10^7 to 10^8 cm/sec. The wave length in abnormal discharge is shorter, indicating the electron concentration exceeds the critical. The transverse electromagnetic wave transforms partially into a surface wave. (tr-auth)

6386 PLASMA PHYSICS AND THERMONUCLEAR RESEARCH. C. L. Longmire, James L. Tuck, and W. B. Thompson, eds. Progress in Nuclear Energy Series. A Pergamon Press Book. Progr. Nucl. Energy, Ser. XI, 2: 1-367(1963). New York, The Macmillan Co., 1963.

Separate abstracts were prepared for ten of the twelve papers included. Two papers, on trapping and containment of plasma in cusped magnetic field configurations, were previously abstracted in NSA. (D.C.W.)

For abstracts of individual papers see: 6387, 6388, 6389, 6390, 6391, 6392, 6393, 6394, 6395, and 6396.

6387 SUMMARY OF THE LRL MIRROR MACHINE PROGRAM, 1958-60. Richard F. Post (Univ. of California, Livermore). Progr. Nucl. Energy, Ser. XI, 2: 1-100(1963).

The most significant developments in the experimental and theoretical investigations of the mirror machine as a thermonuclear reactor are summarized. 68 references. (D.C.W.)

6388 ON THE WORK ON THE THERMONUCLEAR EXPERIMENTAL FACILITY OGRA. I. N. Golovin, L. I. Artemenkov, G. F. Bogdanov, D. A. Panov, V. I. Pistunovich, and N. N. Semashko (Inst. of Atomic Energy, Academy of Sciences, USSR). Progr. Nucl. Energy, Ser. XI, 2: 101-19(1963).

The critical current and vacuum conditions required for accumulation of a dense plasma in OGRA are analyzed on the basis of measurements; and the effects of stability, space charge, and ion cooling by electrons on accumulation are considered. The results of OGRA tests up to October, 1960, are also summarized. (D.C.W.)

6389 THE DCX PROGRAM. J. S. Luce (Aerojet-General Nucleonics, San Ramon, Calif.). Progr. Nucl. Energy, Ser. XI, 2: 120-49(1963).

Results obtained with DCX-1 between Sept. 1958 and July 1960, and the status of the DCX-EP-B and DCX-2 devices as of July 1960, are summarized. Dissociation and other arc experiments in the period are reviewed, and some injection and trapping devices are discussed. (D.C.W.)

6390 STUDIES OF PLASMAS IN FAST MAGNETIC COMPRESSION EXPERIMENTS. Warren E. Quinn (Los Alamos Scientific Lab., N. Mex.). Progr. Nucl. Energy, Ser. XI, 2: 150-88(1963).

The experimental arrangements and diagnostic devices used in fast magnetic compression experiments are summarized, and experimental and theoretical studies on initial current sheath, stability, containment, continuum radiation, and d-d reactions in fast magnetic compression devices are reviewed. 65 references. (D.C.W.)

6391 ROTATING PLASMA DEVICES. Bo Lehnert (Royal Inst. of Tech., Stockholm). Progr. Nucl. Energy, Ser. XI, 2: 201-46(1963).

Theoretical and experimental investigations on a rotating magnetized plasma are reviewed. The behavior of the plasma is described both from a microscopic and a macroscopic viewpoint. The confinement of the plasma in the magnetic field and its equivalent electric circuit receive particular attention. Experimental results recently obtained with rotating plasma devices are also described, and applications to the thermonuclear fusion problem as well as to astrophysics are discussed. 55 references. (auth)

6392 THE PROBLEMS OF THE CYCLOTRON RADIATION. Werner B. Riesenfeld (Los Alamos Scientific Lab., N. Mex.). Progr. Nucl. Energy, Ser. XI, 2: 247-58 (1963).

The single particle model is used to investigate the angular dependence of cyclotron radiation emission, the rate of energy transfer to electrons, and the effect of reflectors on radiation losses. The collective model for cyclotron radiation is shown to confirm the results Trub-

nikov and Kudryavtsev obtained with the single particle model. (D.C.W.)

6393 HARD-CORE PINCHES. Harold P. Furth (Univ. of California, Livermore). Progr. Nucl. Energy, Ser. XI, 2: 259-70(1963).

Some experimental and theoretical findings on the stability of dynamic and quasi-static hard-core pinches are summarized to assess the applicability of the standard hydromagnetic stability theory. The prospects of stable plasma containment are also considered. (D.C.W.)

6394 INFINITE CONDUCTIVITY THEORY OF THE PINCH. V. SURFACE LAYER MODEL IN THE LIMIT OF NO COLLISIONS. M. Rosenbluth. Progr. Nucl. Energy, Ser. XI, 2: 271-7(1963).

The mechanism of conductivity and particle reflection at the surface is calculated by obtaining a self-consistent solution of Maxwell's equations for the fields in the surface layer. (D.C.W.)

6395 PICKET FENCE. J. L. Tuck. Progr. Nucl. Energy, Ser. XI, 2: 278-85(1963).

The magnetic field of a picket fence configuration is described, and the containment properties of three embodiments of the concept are discussed. The power required to produce a given magnetic field in such an arrangement and the size of a toroidal picket fence container are calculated. The effects, origin, prevention, and reduction of plasma motion as a whole, with no charge transport, are also considered. (D.C.W.)

6396 ACCELERATION OF PLASMA. W. H. Bostick (Stevens Inst. of Tech., Hoboken, N. J.). Progr. Nucl. Energy, Ser. XI, 2: 292-352(1963).

The theory, design, performance, and properties of some plasma accelerators representative of the development of such devices are reviewed. 44 references. (D.C.W.)

6397 IMPROVEMENTS RELATING TO DISCHARGE TUBES FOR HIGH CURRENT ELECTRICAL DISCHARGES. Thomas Edward Allibone, Douglas Richard Chick, and Alan Alfred Ware (to Associated Electrical Industries Ltd.). British Patent 937,844. Sept. 25, 1963. Filed Apr. 14, 1959.

A toroidal discharge tube for high-current electrical discharges is provided with a toroidal graphite liner having a high electrical resistance. The liner is supported within the torus by insulating spacers. It may be either continuous or constructed of a number of sectors in contact. The liner reduces the tendency for arcing to occur across gaps in the torus. (A.G.W.)

6398 CONTINUOUS PLASMA GENERATOR. Wallace D. Kilpatrick (to U. S. Atomic Energy Commission). German Patent 1,153,463. Aug. 29, 1963. Priority date May 6, 1958, United States.

A plasma generator for producing a continuous stream of plasma is described. It consists of an elongated apertured anode, a first electrode disposed adjacent to one end of the anode, and a second electrode disposed adjacent to the other end of the anode and having an opening substantially the same size as the anode aperture. Means are provided for introducing a gas into the anode aperture, for maintaining the anode at a substantial positive potential with respect to the first and second electrodes to establish a plasma within the anode aperture, and for establishing a magnetic field axially through the anode aperture with a peak intensity at a point in the anode aperture with a magnetic field gradient extending from the point towards the first and second electrodes. The magnetic field restrains charged particles from imping upon the anode and additionally urges charged particles from the anode through the aperture in the second electrode for the continuous ejection of plasma. (Gmelin Inst.)

6399 APPARATUS FOR HEATING GASEOUS MATERIALS. Milton U. Clauser, Rudolf X. Meyer, Richard H. Huddlestone, and Burton D. Fried (to Space Tech. Labs., Inc.). U. S. Patent 3,102,088. Aug. 27, 1963. Filed Dec. 12, 1958.

An improved apparatus for accelerating gas particles to high kinetic energy levels by means of the pinch effect is described. An inner cylindrical capacitor plate is coaxially arranged within an outer cylindrical capacitor plate with the discharge tube being disposed between the capacitor plates in a region substantially equidistant from the ends of the plates so that stored energy in the peripheral regions of the capacitor arrives at the discharge tube at substantially the same time. A switching device is connected between the discharge tube and one of the cylindrical capacitor plates so that the capacitor may be selectively discharged through the discharge tube. A shock tube is arranged to ionize the gas utilized and drive it into the discharge tube with a sequence timing arrangement included to trigger automatically the switching device to initiate the discharge of the capacitor through the discharge tube at the optimum time. By disposing the discharge tube symmetrically with respect to the peripheral boundaries of the capacitor plates, adverse inductance and transit time difficulties are minimized. By the use of coaxial capacitor plates, the outer capacitor plate may be held at ground potential and the isolated inner capacitor plate charged so as to achieve safety in operation and absence of corona discharge. (A.G.W.)

6400 GAS DISCHARGE APPARATUS. Robert Carruthers and Peter Clive Thonemann (to United Kingdom Atomic Energy Authority). U. S. Patent 3,105,027. Sept. 24, 1963. Priority date Oct. 11, 1957, Great Britain.

In the apparatus considered, a high-current ring discharge is induced in gas in a vessel by the application of a short high-voltage pulse from a first energizing circuit to a primary winding of a pulse transformer whereof the ring discharge forms a single-turn secondary winding. A second energizing circuit adapted to produce a relatively low voltage output of relatively long duration is coupled to the secondary winding in order to maintain the discharge current at a high value for a prolonged period when the high voltage pulse has fallen to zero. The first energizing circuit may comprise a capacitor and switch means for discharging the capacitor through the primary winding of the pulse transformer. The second energizing circuit may comprise a charged delay line and may be adapted to store energy at high voltage, a second pulse transformer being provided for reducing the high voltage to the required low voltage. (A.G.W.)

6401 GAS DISCHARGE APPARATUS. Peter Clive Thonemann, Anthony Emerson Robson, and Roger Norman Hall (to United Kingdom Atomic Energy Authority). U. S. Patent 3,105,031. Sept. 24, 1963. Filed July 1, 1959.

In the gas discharge apparatus described, the metallic surface exposed to the discharge is formed of a plurality of closely spaced, mutually insulated, thin metallic plates mounted substantially edge-on to the discharge. The edge dimensions and spacing of the plates are such that the effective area of each plate exposed to the discharge is less than that required to maintain a unipolar arc. The plates may consist of arcuate portions of radially slotted plate-like metallic rings bonded together by means including an insulant over an area extending part way from the outer

edge of each ring toward the inner edge. The rings may be spaced apart by the insulant and some of the rings may be of tapered cross section. The portions of the plates nearest the discharge may be bent so that the insulation between adjacent plates is not directly exposed to the discharge. Methods of producing the surface described are suggested. (A.G.W.)

6402 REACTOR FOR NUCLEAR FUSION. George Jiri Linhart. U. S. Patent 3,113,917. Dec. 10, 1963. Priority date Dec. 3, 1959, Belgium.

A thermonuclear reactor of the electrical discharge type is designed with improved efficiency. In the operation of the reactor, a high vacuum ($\sim 10^{-6}$ mm Hg) is set up in a cylindrical vessel, a gas (preferably $D_2 + T_2$) is introduced intermittently into the vessel through orifices in the curved wall of the vessel, and the resulting cylindrical gas layers are subjected to electrical discharges. (D.L.C.)

6403 METHOD OF PRODUCING NEUTRONS. Donald H. Imhoff and W. H. Harker (to U. S. Atomic Energy Commission). U. S. Patent 3,117,912. Jan. 14, 1964.

This patent relates to a method of producing neutrons in which there is produced a heated plasma containing heavy hydrogen isotope ions wherein heated ions are injected and confined in an elongated axially symmetric magnetic field having at least one magnetic field gradient region. In accordance with the method herein, the amplitude of the field and gradients are varied at an oscillatory periodic frequency to effect confinement by providing proper ratios of rotational to axial velocity components in the motion of said particles. The energetic neutrons may then be used as in a blanket zone containing a moderator and a source fissionable material to produce heat and thermal neutron fissionable materials. (AEC)

Shielding

6404 (ORNL-3499(Vol.I)(p.131-6)) A STUDY OF THE RADIATION SHIELDING CHARACTERISTICS OF BASIC CONCRETE STRUCTURES AT THE TOWER SHIELDING FACILITY. V. R. Cain (Oak Ridge National Lab., Tenn.).

The protection against prompt weapons radiation afforded by various typical structures was investigated at the Tower Shielding Facility. Prompt weapons radiations were simulated by the Tower Shielding Reactor II, and fast-neutron and gamma-ray dose rates and thermal-neutron fluxes were measured within two concrete-shielded bunkers and an interconnecting tunnel. Typical results are presented. (auth)

6405 (ORNL-3499(Vol.I)(p.137-46)) CALCULATIONS OF THERMAL-NEUTRON FLUX DISTRIBUTIONS IN MULTILEGGED DUCTS USING AN ALBEDO MODEL WITH MONTE CARLO TECHNIQUES. V. R. Cain (Oak Ridge National Lab., Tenn.).

Experiments at the Tower Shielding Facility with multilegged duct geometries indicate that gamma radiation from low-energy neutron capture in the duct walls is significant. The low-energy neutron distributions were calculated for straight-duct geometries and for three-legged rectangular ducts using an albedo model and a Monte Carlo technique. A digital computer program was written to perform the calculations. (auth)

6406 (ORNL-3499(Vol.I)(p.165)) PROGRAM OF RADIATION SHIELDING INFORMATION CENTER (RSIC). S. K. Penny, D. K. Trubey, and Betty F. Maskewitz (Oak Ridge National Lab., Tenn.).

The activities and services of the center, which collects, organizes, evaluates, and disseminates radiation shielding information, are described. (D.C.W.)

6407 (ORNL-3499(Vol.I)(p.166-7)) RSIC INFORMATION RETRIEVAL SYSTEM. S. K. Penny, D. K. Trubey, and M. B. Emmett (Oak Ridge National Lab., Tenn.).

An information retrieval system consisting of three types of programs for the IBM-7090 computer was developed for storing bibliographic and indexing information and for periodically producing a shielding bibliography. (auth)

6408 (PAN-402/VI) CASCADE CURVES FOR LEAD FOR THE PRIMARY PHOTON AND ELECTRON OF ENERGY ($3.10^8 - 10^{14}$) ev. Z. Buja (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 14p.

The cascade curve calculations by Ott for the energy interval 3×10^8 to 10^{11} ev were repeated, and additional calculations for energies of 3×10^{11} to 10^{14} ev were made. The numerical results are tabulated. (D.C.W.)

6409 THE ABSORPTION OF HIGH-ENERGY RADIATION, A MONTE CARLO STUDY. III. DENSITY AND TRANSPARENCY DISTRIBUTIONS. N. R. Steenberg and W. P. Crofts (Univ. of Toronto). Can. J. Phys., 41: 2206-40(Dec. 1963).

Random spherical arrays of rigid spheres are being studied as a model for a nucleus under high-energy bombardment. The distribution of sphere centers, the matter distribution, and the transparency for such arrays is reported. Low (12.5%) and high (42.2%) nominal densities are treated for arrays numbering 27 and 216 spheres. At high densities a strong surface correlation of geometric origin is observed. Analytic formulas are presented that, in general, adequately represent the Monte Carlo data. (auth)

6410 CALCULATION OF THE SHIELDING FOR HOT CELLS. J.-M. Pictet (EIR, Wurenlingen, Ger.). Neue Tech., 5: 504-8(Sept. 1963). (In German)

The shielding required for the universal cell and for the 1000-c cell is calculated, and the calculation method is discussed. The characteristics of the shielding separating one 1000-c cell from another are determined. (J.S.R.)

REACTOR TECHNOLOGY

General

Refer also to abstract 5744.

6411 (ANL-6706) IDAHO DIVISION SUMMARY REPORT, OCTOBER 1961–SEPTEMBER 1962. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 160p.

Research and development progress is reported on the ZPR-III, EBR-I, EBR-II, AFSR, TREAT, and BORAX-V. (M.C.G.)

6412 (GEAP-3888) SODIUM-COOLED REACTORS PROGRAM, FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. First Quarterly Report, October–December 1961. F. J. Leitz, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT(04-3)-189. 168p.

Progress is reported on the development of the Fast Ceramic Reactor. Information is reported on EFCR design and planning, vented fuel development, fuel testing in TREAT, mixed carbide fuel study, fuel fabrication development, reactor dynamics analysis, and reference design evaluation. (N.W.R.)

6413 HEAVY WATER LATTICES: SECOND PANEL REPORT. Report of the Second Panel on Heavy Water Lattices held in Vienna, 18-22 February, 1963. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 20. Sept. 1963. 653p. (STI/DOC/10/20). $13.00; Sch 273; 78s.stg; F.fr. 52; DM 45.50(IAEA)

Reports are given on the status of heavy-water technology in various countries. Twenty-six papers are included on various aspects of heavy-water reactor physics. Fifteen papers were chosen for NSA, seven having previously been abstracted. (R.E.U.)

For abstracts of individual papers see: 6414, 6415, 6450, 6451, 6452, 6453, 6454, 6455, 6456, 6457, 6458, 6503, 6532, 6533, and 6534.

6414 THE AGE OF NEUTRONS IN HETEROGENEOUS LATTICES. V. C. Deniz (Atomic Energy Establishment, Trombay, India). p.189-99 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

The age of neutrons in heterogeneous systems is considered in terms of the various groups of fast neutrons available for slowing down. Special emphasis is given to the age of neutrons that are not inelastically scattered. A general formalism is developed assuming that only neutrons above the fast-fission threshold of U^{238} suffer inelastic collisions. A particular formula for natural-uranium heavy-water systems is presented and numerical comparison is made between the values as obtained by this formula and another that assumes that neutrons, which were not inelastically scattered, have an age corresponding to that of the fission spectrum. The values of the age from this formula are found to be significantly lower. It is seen that the inelastic scattering of neutrons that are below the fast-fission threshold leads to a still further reduction in the values of the age. The theoretical analysis in connection with the age leads to more precise formulations for the fast-fission factor and the effective delayed neutron fractions. (auth)

6415 A PRELIMINARY DESCRIPTION OF THULE. D. C. Leslie and M. J. Terry (Atomic Energy Establishment, Winfrith, Dorset, Eng.). p.417-43 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963. (AEEW-R-250)

THULE is a multigroup transport calculation in cylindrical geometry for single lattice cells; although originally intended for reactors of the Pressure Tube Heavy Water variety, it is applicable to a much wider range of systems. In the version described fast events (10 Mev to 5.53 kev) are represented by two wide groups in which the fitted cross sections of Ombrellaro are used. Resonance events (5.53 kev to 4 ev) are calculated by the Monte Carlo code MOCUP; in this region, the geometry of the fuel element is represented precisely. Thermal events (below 4 ev) are treated by means of 42 nonoverlapping groups in which the basic data is used. In these groups, thermalization is represented by the width model for H_2O, and by the free gas model for other moderators. In spite of its elaboration THULE is intended to be a practical tool. As an example of its use, the calculation of the void coefficient of a typical boiling PTHW is described. This THULE calculation is compared with the predictions of the METHUSELAH method, which is described in a previous paper by Hicks. (auth)

6416 SHIELDED REACTOR PLANT ARRANGEMENT AND PERSONNEL ACCESS MEANS THEREFOR. William A. Webb, John R. Huston, Walter P. Haass, and Woodrow E. Johnson (to Westinghouse Electric Corp.). U. S. Patent 3,113,915. Dec. 10, 1963. Filed May 14, 1957.

A plant layout for a homogeneous reactor system is described which has improved biological shielding and which provides limited access for maintenance personnel during reactor operation. The reactor equipment is grouped and shielded according to the radiation levels, and nonradioactive operating controls and instrumentation are enclosed for ready maintenance during operation. Means is also provided for quickly replacing some of the equipment for service in a hot cell. (D.L.C.)

Auxiliaries and Components

6417 (CONF-243-34) OPERATIONAL CONTROL ROD REACTIVITY WORTHS FROM OBSERVED HEAT GENERATION RATES. J. R. Fredsall and C. E. Bowers (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 7p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Control rod reactivity worths can be determined with reasonable accuracy from estimates of the neutron absorption rate in the rods and evaluation of the change in reactor leakage rate on rod withdrawal. In the Hanford reactors these values are found from measured control rod heat generation and reactor flux distribution data. This calibration technique can also be applied to reactors without separate rod-cooling systems. The neutron absorption rate in the rods is obtained from rod surface foil activation or activation of the rods themselves. The change in reactor leakage upon rod insertion is found with theoretical determinations of the unperturbed flux distribution and the flux distribution after insertion of an equivalent control region. (auth)

6418 (GAMD-3470) STRUCTURAL ANALYSIS OF REACTOR VESSEL AND ASSOCIATED COMPONENTS. PHASE I. C. E. Aldrich, Jr., F. G. Bovenzi, L. M. Cassidy, R. L. Dupont, and R. J. McGrattan (General Dynamics Corp. Electric Boat Div., Groton, Conn.). June 17, 1960. Contract AT(04-3)-187. 215p.

The stress analysis of the reactor vessel and its associated components established a basic configuration that is acceptable with respect to primary and primary + secondary stress considerations. A low carbon steel (SA-302B) was selected for the pressure vessel material based on its beginning of life physical properties and cost per pound. Also, SA-302B has no appreciable decrease in stress allowables for an increase in temperature from 650°F to 700°F and would allow a design temperature of 700°F with no change in vessel dimensions. "End of life" properties of this material should be investigated. A 2¼ Cr-1Mo steel was selected for the pressure vessel internals on the basis of its physical properties at 900°F, its low cost per pound compared with stainless or inconel, and its elimination of thermal mismatches between the support skirt and the pressure vessel. A segmented skirt design has been chosen as a reference design for the reactor support. Recommendations are made for further studies. (auth)

6419 (GAMD-3470(App.I)) STRUCTURAL ANALYSIS OF REACTOR VESSEL AND ASSOCIATED COMPONENTS. PHASE I. C. E. Aldrich, Jr., F. G. Bovenzi, L. M. Cassidy, D. J. Duffy, R. L. Dupont, D. A. Duquette, and R. J. McGrattan (General Dynamics Corp. Electric Boat Div., Groton, Conn.). Sept. 29, 1960. Contract AT(04-3)-187. 88p.

The additional items analyzed with suggested modifications where required satisfactorily meet the applicable codes and specifications on the basis of Phase I considerations. The recommended experimental stress program outlined should be carried out to completely evaluate critical areas of the pressure vessel. (auth)

6420 (GEMP-80) REACTOR INSTRUMENTATION AND CONTROL PROGRESS REPORT NO. 80. (General Electric Co. Advanced Technology Services, Cincinnati). Nov. 30, 1963. Contract AT(40-1)-2847. 25p.

Testing of beryllia and thoria dielectric specimens to 4000°F for use in capacitance temperature sensors is reported. Included in this effort is the use of a transistorized oscillator to increase the maximum operating temperature to 3780°F, continued refinement of the 3000°F probe and readout system, and the fabrication of a molybdenum–beryllia vacuum-sealed probe. The testing of fission counter components to 1500°F and the fabrication of d-c ionization chamber parts for testing to 1200°F are summarized. Testing of two gamma-compensated ionization chambers in an alternating current mode is discussed. The design and fabrication of a new ionization chamber suited to a-c operation are described. Charged-fragment neutron detector testing in the presence of x rays, gamma rays, and thermal neutron flux is evaluated. (N.W.R.)

6421 (NP-13339) OPYT RABOTY PRIBOROV DLYA IZMERE NIYA DAVLENIYA I UROVNEI NA I NaK NA USTANOVKE S REAKTOROM NA BYSTRYKH NEITRONAKH. (Operation of Devices for Measuring Pressures and Levels of Na and NaK in Installations with Fast Neutron Reactors). A. A. Petrenko (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 15p.

Level, flow, pressure, and temperature measuring devices were used in measuring the basic parameters of liquid Na and NaK coolants. Descriptions are given of the adjustments made in the devices for static and operational tests in BR-5 (PuO_2, sodium cooled, fast experimental reactor). (R.V.J.)

6422 (PWAC-384) DESIGN SUMMARY REPORT OF LCRE REFLECTOR COOLANT PUMPS AND SUMP. C. Ferguson, L. K. Knudsen, R. P. Lamers, B. R. Lucas, D. V. Manfredi, and H. P. Odom (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Dec. 6, 1963. Contract AT(30-1)-2789. 42p.

The design and development of the Lithium Cooled Reactor Experiment reflector coolant pump and sump unit are summarized. The pump incorporates the design features of a flight-type coolant pump for a nuclear aircraft powerplant. The pump (designated RP-1) is to circulate 700°F sodium–potassium solutions for 10,000 hours without maintenance. (N.W.R.)

6423 REINFORCED CONCRETE REACTOR PRESSURE VESSELS. Th. Jaeger (Kernforschungsanlage Jülich, Ger.). Bauingenieur, 37: 357-61(1962). (Jul-82-RG). (In German)

The characteristics and general construction principles for reinforced concrete reactor pressure vessels are discussed. (M.C.G.)

6424 SELECTION OF THE HEAT TRANSFER FLUID IN A NUCLEAR REACTOR. H. Sureau. Ind. Chim. Belge, 28: 1071-84(Oct. 1963). (In French)

After a brief review of the nuclear, chemical, physical, and, particularly, thermal properties required of a reactor coolant fluid, the behavior of the usual fluids (water, organic liquids, liquid metals, and certain gases, nitrogen, helium, and carbon dioxide) is studied. A numerical comparison is then made of the cooling capacities given by these materials. The possibilities for the utilization of these fluids in reactors of various types are deduced. (tr-auth)

6425 ORGANIC HEAT CARRIERS (COOLANTS) AND THE PROSPECTS OF APPLYING THEM IN REACTORS. E. P. Anan'ev. p.177-94 of "Voprosy Teplootdachi i Gidravliki Dvukhfaznykh Sred; Sbornik Statey." S. S. Kutateladze, ed. Moscow, Gosnergoizdat, 1961.

In a nuclear reactor the coolant can be a non-metallic liquid, a gas or a liquid metal. An ideal coolant is defined and the properties of the following substances as coolants are discussed: water, D_2O, liquid metals (Na, K, Hg), Bi, Pb, H_2, He, and LiF. The desirable properties of organic coolants are high boiling point and low melting point, low vapor pressure at high temperatures, resistance to explosion, noncorrosiveness, high thermal and radiation stability, and low cost. Most hydrocarbons are noncorrosive and nonvolatile, but have low thermal conductivity and decompose under irradiation at high temperatures. Organosilicon compounds are being introduced as coolants. Their boiling points are 400 to 440°C and the melting points about –40°C. They are nonexplosive, nonpoisonous, and noncorrosive towards metals. The relevant properties of tetracresyl silicate are described. At 275°C with the wall temperature of 365°C this compound is not subject to decomposition. Studies were made of the hydrocarbons of the diphenylmethane series: ditolylmethane, dicumylmethane, dixylylmethane, tetraisopropyldiphenyl methane. These compounds do not react with carbon steel. The thermal stability of the first three is given in terms of their properties after various periods of boiling. The diphenyl mixture (a eutectic of diphenyl and diphenyl ether) is widely used on account of its

good coolant properties, but its pecific heat is 1.5 times, and the latent heat of evaporation 4 to 5 times, lower than that of water. The rate of decomposition is highest in the boundary layer due to the high temperature gradient, but can be reduced 1.5 times by increased circulation. The coefficient of heat transfer depends on the motion of the viscous layer adjoining the heating surface and, therefore, on the temperature differential, Δt between that surface and the coolant. When Δt exceeds 8 to 10°C, bubble boiling goes over into film boiling causing a rapid increase of the wall temperature. The critical heat loads depend on the material of the heating surface but not on their geometry. A comparison was made between glycerin, poly- and mono-esters, tetrachlorodiphenyl and the diphenyl mixture as coolants. The diphenyl mixture in combination with other hydrocarbons is regarded as the most promising coolant for atomic reactors. Finally, the organic coolant moderator used in the American reactor OMRE is described. (OTS)

6426 MONITORING SCANNING VALVE, 48 PORT (Engineering Materials). (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). (CAPE-1047)

This package contains 10 drawings. The sample-scanning valve or fluid switch, monitors fuel-coolant streams for radioactivity. This valve samples 48 input lines in sequence. The system operates at 600°F and at a pressure of 1,500 psig. Rapid changes in temperature have no adverse effect on operation. The main body of the apparatus is constructed of a 10-in., 900-lb blind flange and a 10-in., 900-lb weld-neck flange and associated piping. Forty-eight input and 2 output sample lines enter through the blind flange and exit to a port block. A port selector is driven in 15° steps by a stepping meter which diverts two sample streams at a time through two outlet ports. (F.S.)

6427 MEANS FOR RETAINING NUCLEAR FUEL ELEMENTS AT ONE END OF A REACTOR DUCT. Noel Laurent and Alphonse Peuchmaur (to Commissariat a l'Energie Atomique). British Patent 938,167. Oct. 2, 1963. Priority date June 6, 1961, France.

A retaining device located at one end of a nuclear reactor duct prevents back movement of nuclear fuel elements after they have been inserted into the duct past the device in a predetermined direction. The device includes detents formed by the free ends of resilient tongues carried by a cylindrical base member mounted around a supply duct for the fuel elements. Each detent has an internal face forming an inclined ramp, which encounters each fuel element introduced. The front end of the element pushes back the detents, which remain in their deformed position until the entire element has passed by and then resiliently resume their initial position. In this position any backward movement of the fuel elements causes a rear shoulder of the detent to abut against the end of an extension of the supply duct. The device is designed for a normal thrust of ~400 kg at 500°C and is capable of supporting a thrust of 1000 kg without breaking. (A.G.W.)

6428 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT CHARGING ARRANGEMENTS. (to Societe Indatom and Compagnie des Ateliers et Forges de la Loire). British Patent 938,179. Oct. 2, 1963. Priority date Mar. 27, 1959, France.

A nuclear reactor loading tube receivable by a standpipe through the reactor pressure vessel includes a pair of coaxial sleeves movable axially relative to one another. A guide tube is pivotally coupled to one sleeve, and a coupling member is pivotally coupled to the guide tube and to the other sleeve. Means are provided to cause relative axial movement of the sleeves to angularly displace the guide tube about its pivoted connection with the sleeve. The coupling member, the guide tube, and the sleeve to which the guide tube is coupled together form a tubular passage when the guide tube, sleeve, and coupling member are coaxial. The sleeve to which the coupling member is pivotally connected is extended below the pivot by a rigid part provided at its free end with a head, formed to engage and center with the opening of a given fuel channel served by the standpipe. Means are provided to ensure that the loading tube is gas tight. (A.G.W.)

6429 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR INSTALLATIONS. Ronald Scott Challender and Sydney Fawcett (to United Kingdom Atomic Energy Authority). British Patent 938,190. Oct. 2, 1963. Filed Nov. 2, 1960.

The design of the containment vessel described is based on the conception of a large volume of coolant escaping in two phases: a first phase in which a large volume of coolant escapes from the reactor installation at relatively high pressure and is not seriously contaminated, and a second phase in which a relatively small volume of contaminated coolant escapes at low pressure. The vessel is unsealed at pressures above about 5 psi and sealed at a lower pressure that is still above atmospheric pressure by a non-return valve disposed in a duct extending upwardly from the upper region of the vessel. Several modifications of the valve are described. By this arrangement the reactor shield can act as containment vessel. (A.G.W.)

6430 IMPROVEMENTS IN OR RELATING TO THE MONITORING AND CONTROL OF NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 938,252. Oct. 2, 1963. Priority date July 31, 1961, United States.

The control-rod-integrity monitoring system described generally includes an electrical conductor extending along a control rod in a nuclear reactor and secured to the control rod at least at two locations along it. Electrical instruments responsive to an open circuit are connected to the conductor. Any separation in the control rod between the two secured locations severs the conductor, and the electrical instruments yield an indication of the separation. The electrical instruments can be used to prevent any unusual power level variation that may result from such a separation of the control rod. (A.G.W.)

6431 IMPROVEMENTS IN OR RELATING TO NEUTRON SHIELDING STRUCTURES. Wyndam Morgan John and Harold Hodgson Nicholson (to United Kingdom Atomic Energy Authority). British Patent 938,257. Oct. 2, 1963. Filed Oct. 18, 1960.

A neutron shielding structure for a duct by which coolant is conducted to or from a nuclear reactor core region comprises at least three separate neutron-absorbing members spaced from one another along the interior of a portion of the duct extending away from the core region so as to define paths for coolant flow. The first and second of the members are of annular form disposed coaxially in the bore of the duct with the first member having an outer periphery extending to the duct wall and the second member having an outer periphery of greater span than the inner periphery of the first member. The third member comprises an elongate body disposed lengthwise along the axis of the duct, the periphery of the body having a span greater than the inner periphery of the second member. The duct may be disposed coaxially within a further duct, and in the interspace between the ducts may be disposed further neutron-absorbing members spaced to define paths for coolant flow. The further members are also disposed so

that one overlaps another to impede neutrons streaming along the interspace. The inner of the two ducts may be withdrawable from the outer. (A.G.W.)

6432 IMPROVEMENTS RELATING TO CONTROL RODS FOR USE IN NUCLEAR REACTORS. Stanley Edgar Barden, Colin Turner Downie, John Anthony Wynne Huggill, and Alfred Zelma Keller (to A.E.I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 938,395. Oct. 2, 1963. Filed Sept. 24, 1959.

The composite control rod described consists of an outer sheath of a material strongly absorbent for slow neutrons and an inner core of a solid material capable of slowing fast neutrons that have passed through the sheath. The outer sheath of the composite rod may consist of a ferrous alloy containing a small percentage of boron. The inner core of the control rod may consist of graphite. The core may be made from sections of graphite formed by an extrusion process, and the use of high-purity graphite is not essential. In a graphite-moderated uranium reactor, this method can increase the effectiveness of the rod by a factor that can approach two. (A.G.W.)

6433 ELECTROMAGNETIC DISPLACING MEANS FOR NEUTRON ABSORBING CONTROL RODS. Ludwig Dreyfus and Stig Ericsson (to Allmanna Svenska Elektriska Aktiebolaget). German Patent 1,153,122. Aug. 22, 1963. Priority date June 2, 1958, Sweden.

The electromagnetic displacing means described comprises a longitudinally extended stator composed of equal soft iron rings slid on a nonmagnetic tube and provided with slots for receiving coils fed by direct currents, which have the same magnitude as the instantaneous values of a polyphase current system and provide an axially directed multipolar direct-current field being displaceable with respect to the stator. The armature that supports the control rod comprises ring-shaped pole pieces forming progressively north and south poles with permanent magnets between. The pole pitches of the stator and the armature are slightly different for eliminating the slot harmonics of the traction curve. (Gmelin Inst.)

6434 METHOD AND MEANS FOR CONTROLLING THE REACTIVITY OF A NUCLEAR REACTOR. Jacky Weill (to Commissariat à l'Energie Atomique). German Patent 1,153,467. Aug. 29, 1963. Priority date Jan. 29, 1958, [France].

The means described comprise in combination at least one control element capable of modifying the reactivity of the reactor as a function of the flux of active neutrons to which it is submitted, and screening means of black fuel for the active neutrons. The area of the element exposed to active neutron flow is variable by relative movement of the element and the screening means. (Gmelin Inst.)

6435 POSITIONING MEANS FOR THE CONTROL ROD IN A NUCLEAR REACTOR. Francis R. Bell (to De Havilland Engine Co.). German Patent 1,154,883. Sept. 26, 1963. Priority date July 9, 1959, Great Britain.

An electric motor and transmission means for adjusting the position of the control rod in relation to the reactor core to control the level of activity in either sense and a lock that is retained in a locking condition by a longitudinal force derived electrically from the motor but arranged to be released when the electrical force is removed to allow the control rod in an emergency to drop into its shut-down position are described. (Gmelin Inst.)

6436 SYSTEM FOR SUPPORTING NUCLEAR FUEL IN ATOMIC REACTORS. Michel Aubert, Sebastien Foglia, and Roland Roche (to Commissariat a l'Energie Atomique). U. S. Patent 3,100,743. Aug. 13, 1963. Priority date Nov. 22, 1958, France.

In the system described for supporting fuel elements in nuclear reactors of the type using vertical ducts, each fuel element is made to support only its own weight. Each element is surrounded by an armature made of material of low neutron absorption and rests upon a support made of a similar material. The support is suspended from the outer armature by one or more wires of a high tensile material, which extend through the support and are wound around the armature in a lateral groove formed therein. Another groove is preferably provided at the top of the armature to facilitate handling of the assembly. (A.G.W.)

6437 NUCLEAR REACTOR CONTROL ROD AND METHOD OF MAKING SAME. Lambert F. Kooistra (to The Babcock and Wilcox Co.). U. S. Patent 3,103,478. Sept. 10, 1963. Filed Jan. 9, 1959.

In the suggested method of making control rods, high neutron-absorbing material is placed in a plurality of holes drilled parallel to the longitudinal axis in an elongated strip of metal. The metal is then roll formed so as to provide a relatively flat metal strip having severely elongated elliptical holes filled with neutron-absorbing material. The holes are placed in non-touching but overlapping relationship to each other such that large areas are essentially opaque to neutrons. Suitable neutron-absorbing materials include boron, cadmium, hafnium, or their compounds. (A.G.W.)

6438 NUCLEAR REACTOR CONTROL RODS. Jackson A. Ransohoff. U. S. Patent 3,103,479. Sept. 10, 1963. Filed Apr. 20, 1959.

The control rods described are of a laminated configuration intended to extend the effective lifetime of the rod. The rods may be of any overall shape and may contain any of a number of neutron-absorbing materials including rare earths as well as Hf, B, Li, and Co. In general the rods consist of a core of epithermal neutron-absorbing material, a layer of thermal neutron-absorbing material, and a corrosion-protective cladding. There may be incorporated into the rod also material that becomes a useful product when irradiated by neutrons. For example, Co^{60} for use as radiation sources can be produced by placing Co in the control rod. (A.G.W.)

6439 FUEL ELEMENT DISCHARGE SYSTEMS FOR NUCLEAR REACTOR. Everett Long (to United Kingdom Atomic Energy Authority). U. S. Patent 3,104,217. Sept. 17, 1963. Priority date June 24, 1957, Great Britain.

A system is described for discharging fuel elements from vertically oriented nuclear reactors by access from the top of the reactor. The upper face of the reactor core assembly is separated from the top shield structure by a space in which the fuel channels terminate. A fuel element discharge channel extends from the same space to a discharge point below the shield structure. A portion of the top shield structure consists of a rotatable wheel upon which a fuel element manipulating machine is mounted eccentrically in such a manner that it can move between the terminal ends of the fuel channels and the fuel element discharge channel. Fuel elements can thus be removed from the reactor without penetrating the shielding above the reactor. (A.G.W.)

6440 FLUID CIRCUITS. Samuel Brittan Hosegood, Brian Edward Puffett, and Joseph Henry Swain (to United Kingdom Atomic Energy Authority). U. S. Patent 3,105,025. Sept. 24, 1963. Priority date June 5, 1957, Great Britain.

A means of connecting a component into a fluid circuit located within a containing vessel is described. A recess in the wall of the containing vessel has inlet and outlet pipe openings leading into the vessel. A container for the component is adapted to fit in the recess and has inlet and outlet ports in the wall for connection to the component. Means for making at least a partial seal between the container and the recess is located between the inlet and outlet ports, and means for making a second seal is located between the ports and the outer end of the container. The vessel may be enclosed in a thick-walled shield with the walls of the recess extending through the thick wall. A third seal is then made outside the shield. The portion of the container inside the shield is sealed off by an internal plate, and the space between the plate and the outer end of the container contains shielding material. The fluid circuit may be the coolant circuit or fluid-fuel circuit of a nuclear reactor. (A.G.W.)

6441 APPARATUS FOR REMOVING CONTAMINATED COOLANT FROM REACTOR SYSTEM. Everett Long (to United Kingdom Atomic Energy Authority). U. S. Patent 3,105,028. Sept. 24, 1963. Priority date Feb. 12, 1958, Great Britain.

The apparatus described is intended for use with a reactor using sheathed fuel elements, a closed CO_2 cooling circuit, and a valve for relieving pressure in the coolant circuit. A duct is provided from the valve to an absorption tower through which liquid NaOH is circulated. The coolant gas is removed in the form of a sodium carbonate sludge. A gas holder may be connected in closed circuit with the absorber. (A.G.W.)

6442 EQUIPMENT FOR AUTOMATIC CONTROL OF ATOMIC REACTOR. Pavel Kovanic and Milan Kulka (to Zavody V. I. Lenina Plzen). U. S. Patent 3,105,029. Sept. 24, 1963. Priority date Feb. 18, 1958, Czechoslovakia.

The equipment for automatic reactor control includes individual servodrives for each of several control rods. The servodrives are sequentially brought into action by a programming device according to the desired program of reactor output. At least one control rod is equipped with a servodrive independent of the programming device. A detecting element moved by another servodrive measures the intensity of radiation. The signal from the detecting element is compared in a reference circuit with a signal from a reference source. Amplifiers and an integrator are used to transmit the error signal of the reference circuit to one of the servodrives. Suitable switching devices make the apparatus usable throughout the full range of power levels. (A.G.W.)

6443 NUCLEAR REACTOR SHUTDOWN APPARATUS. George Camac (to A.E.I.-John Thompson Nuclear Energy Co. Ltd.). U. S. Patent 3,105,033. Sept. 24, 1963. Priority date Nov. 14, 1958, Great Britain.

Apparatus is described for rapidly shutting down a nuclear reactor in the event of failure of normal shutdown means. A reservoir containing neutron absorbent material in a form having fluid properties is located above the reactor core. Ducting leads from the reservoir and extends within the core in such a manner that the neutron-absorbent material may pass into the core on receipt of an operating signal. Means for removing the material from the core are also provided. The neutron-absorbent material may be in the form of pellets or small particles. The pellets are preferably balls about $^3/_8$" in diameter made of stainless steel containing boron. Alternatively, the balls may be made of glass containing boron or may be in the form of sand. The ducting may comprise an upper tube and a lower tube adapted to fit within the upper tube, with means for lowering the lower tube from within the upper tube so that it extends within the core of the reactor. (A.G.W.)

6444 DEVICES FOR REMOVING FISSIONABLE MATERIAL RODS FROM NUCLEAR REACTORS. Sebastien Foglia (to Commissariat a l'Energie Atomique). U. S. Patent 3,105,034. Sept. 24, 1963. Priority date June 30, 1955, France.

The device is used in connection with gas-cooled reactors having a block of solid moderator pierced by a plurality of horizontal channels housing fuel slugs. A plurality of parallel inclined chutes runs along the outlet face of the moderator block. Each chute passes slightly below and parallel to an oblique row of channel discharge ends. Curved guiding elements connect the discharge ends with the chutes. Each inclined chute connects with a helical chute, preferably located inside the shield, which consists of a curved steel angle arranged along the inside wall of a circular cylinder with vertical axis. The bottom end of the helical chute is connected to an inclined conduit extending through the shield into a chamber provided with means for receiving spent or burst slugs. The slugs are pushed out of the reactor by conventional means, and the slope of the chutes is so arranged that the slugs slide by gravity at a suitable speed. (A.G.W.)

Crititicality Studies

Refer also to abstract 5574.

6445 (AAEC/E-111) A BASIS FOR THE COMPUTATION OF THE ENERGY DEPENDENCE OF THE NEUTRON FLUX AND SLOWING DOWN DENSITY IN A BARE REACTOR. B. R. Lawrence (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1963. 12p.

A method is described for computing the energy dependence of the neutron flux and slowing down density in a bare reactor to form the basis of a 7090 Fortran computer program for survey studies of power reactors. Allowance is made for resonance absorption and resonance fission, neutron thermalization, fast neutron reactions including (n,2n) and (n,n'), and anisotropic elastic scattering. (auth)

6446 (EANDC(E)-46L) INFLUENCE OF NUCLEAR DATA UNCERTAINTIES ON THE THEORETICAL PREDICTION OF DOPPLER COEFFICIENTS IN FAST AND INTERMEDIATE REACTORS. Preliminary Background for the Combined German-French Priority I Requests for Determination of U^{238} and Pu^{239} Resonance Parameters. J. J. Schmidt (Kernforschungszentrum, Karlsruhe, Germany). [1963]. 48p.

Factors affecting the accuracy of neutron resonance parameters in thermal, intermediate, and fast reactors are outlined. Several theories for the Doppler coefficient in fast reactors are reviewed. In the light of these accuracy limitations and theoretical uncertainties, the resonance parameters of U^{238} and Pu^{239} are discussed. Resonance data for these nuclides are reviewed and summarized. (T.F.H.)

6447 (KAPL-2259) AN ANALYTICAL METHOD FOR PREDICTING MULTI-ISOTOPE DEPLETION. Gerhard O. Mueller (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 22, 1963. Contract W-31-109-eng-52. 45p.

A method for calculating the depletion of multi-isotope absorbers that serve as poisons in a nuclear reactor was

developed and evaluated. Two analyses were formulated and a previously developed method was reworked in a more general form and used for comparison purposes. The two methods were based on the solution of the time-dependent neutron balance equation. One method is applicable to cases of spatially invariant flux in a given region, and the other to cases involving spatially varying flux in the radial dimension only. The previous method, also outlined was based on the solution of the coupled fuel and poison depletion equations. With the aid of a digital computer, all three methods were then used to calculate the depletion of certain long-chain isotopes. A comparison of results showed that agreement between the various methods was quite good, and a recommendation for the choice of methods for future study was made. The results of the study are shown graphically, with isotope concentration presented as a function of fractional fuel depletion. (auth)

6448 (NP-13443) OB OPREDELENII PEREDATOCHNOI FUNKTSII REAKTORA METODOM ANALYZA CHASTOTNOGO SPEKTRA FLUKTUATSII. (Determination of Reactor Transfer Function by Means of Analysis of Fluctuation Spectra). I. Purika, I. I. Ioftode, and I. Gyrlya (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Apr. 1963. 8p.

The frequency spectrum of the reactor, which is directly related to the reactor transfer function, yields the same information as the methods based on a pulsed and modulated source; however, it is more convenient to use. The neutron flux measurements are carried by means of a high-efficiency ionization chamber. The average square amplitude of the fluctuation at a given frequency is measured by an analog computer. After making the necessary corrections, the frequency fluctuation spectrum in the reactor lattice is obtained in the form of a Fourier-transform of the neutron flux. For frequencies higher than 10 herz the effect of delayed neutrons may be neglected by considering the reactor subcritical with respect to prompt neutrons. Measurements were carried in the reactor after eliminating the effect of Xe poisoning and under steady-state operation. The frequency spectra were determined for time intervals of 1 week during a 3-month period. The value of $\alpha = (\beta/l)$ was experimentally determined as $177 \pm 10\%$ sec^{-1}. The difference between this value and that measured by means of the reactivity changes is attributed to poisoning by fission products which results in an increase of the macroscopic cross section of the core. (TTT)

6449 CONCERNING THE DISTURBANCE OF THE EPITHERMAL FLUX BY MANY-LAYER PROBES IN FUEL ELEMENTS OF A HETEROGENEOUS REACTOR. Paul Kuttner. Atomkernenergie, 8: 390-4(Nov. 1963). (In German)

The distortion of the epithermal neutron flux by probes of several layers in the fuel element of a heterogeneous reactor is determined by a diffusion theoretical approximation. From that a statement can be made on the best thickness of the fuel layer that should be inserted in the resonance area of the uranium between the cadmium shield and activation foil during activation measurements. (auth)

6450 SOME THEORETICAL STUDIES ON CRITICALITY CALCULATIONS FOR SMALL D_2O ASSEMBLIES WITH HIGH ENRICHMENT. K. H. Joest and G. Memmert. p.147-61 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

Multigroup techniques were used for the DIMPLE experiment using 13 elements with 46% enriched fuel as experimental reference. A method of calculation with the measured microscopic cross sections as the only experimental information is developed. The characteristic values k_∞, τ, and L^2_{th} were determined for homogeneous and heterogeneous approximations in spectrum calculations in the fast and thermal energy range. Though there are rather strong variations in group constants because of the heterogeneity-effects, $k_\infty = 1.77$ remained almost unchanged in this assembly and the migration area varied only by a few per cent. In criticality calculations it was found that one-dimensional calculations with r-z-iteration were rather indefinite because of the strong influence of transverse buckling in the radial reflector. A two-dimensional PDQ calculation eventually resulted in $k_{eff} = 1.015$ for the experimental just critical state. (auth)

6451 CALCULATION OF THERMAL NEUTRON SPECTRA IN D_2O LATTICES. W. Oldekop (Siemens-Schuckertwerke AG, Erlangen, Ger.). p.165-88 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

Three different methods for calculating the spectrum are described. The first of them generalizes the well-known Wilkins' theory in the case of heterogeneous media. The spatial dependence of the spectrum is taken into account with the help of collision probabilities. The second method is a multigroup P_1 approximation. The third is a multigroup-cum-multizone approximation; the multigroup procedure of the P_1 approximation is combined with the multizone procedure of the generalized Wilkins' theory. With the help of a few examples, the three methods are compared both with one another and with other methods. Certain other examples are used to demonstrate the effect of the temperatures of the moderator, the coolant, and the fuel on the neutron spectrum in a typical power reactor. (auth)

6452 BUCKLING MEASUREMENTS OF 3% ENRICHED STAINLESS-STEEL CLAD UO_2 FUEL ELEMENTS IN D_2O MODERATOR. K. Bryhn-Ingebrigtsen, J. Smit, and C. H. Millar (Nora Project, Kjeller, Norway). p.251-4 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

Buckling measurements were carried out in the NORA reactor for a series of uniform, square, D_2O-moderated lattices with moderator-to-fuel ratios ranging from 99:1 to 12:1 for cylindrical fuel rods of the following specifications: Fuel: 3% enriched, unsintered UO_2, density = 9.41 g/cm^3, diam. = 1.128 cm. Cladding: 304 stainless steel, integral diam. = 1.128 cm, outer diam. = 1.270 cm, thickness = 0.071 cm. The buckling values obtained are compared with different theoretical estimates. (auth)

6453 HEAVY WATER LATTICE CALCULATIONS IN SWEDEN. B. Pershagen (Aktiebolaget Atomenergi, Stockholm). p.257-303 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

Calculations are based essentially on a four-factor two-group model. The present standard scheme, BURNUP 5, calculates cell parameters and two-group constants as a function of irradiation. It is used in combination with two-group, one- or two-dimensional diffusion theory codes to predict reactivity, reactivity coefficients, burnup, and other data of interest to reactor design. A comparison of measured and calculated integral data was made for a large number of lattices, including uranium oxide clustered fuel at various lattice pitch, pin pitch, coolant void content, and moderator temperature. The overall agreement is shown to be, in general within 1% in k_{eff}, although systematic deviation seems to occur for low volume ratios and high moderator temperatures. The situation for slightly en-

riched and for irradiated fuel is uncertain due to lack of experimental data. Special investigations were made of void effects, the shielding factor for resonance absorption in clusters and spectrum hardening due to selective absorption in the fuel, including comparison with experiments. The Monte Carlo method was used for studying fast and thermal spectrum effects in heterogeneous media. A two-dimensional fuel depletion code capable of handling intermittent fueling schemes of practical interest has been developed for the MERCURY computer. For the treatment of nonuniform lattices a series of heterogeneous codes based on source and sink theory were developed. Calculated and measured static control rod effects are shown to be in acceptable agreement although the experimental information is very limited. 67 references. (auth)

6454 EXPERIMENTAL REACTOR PHYSICS WORK ON HEAVY WATER LATTICES IN SWEDEN. R. Persson, E. Hellstrand, and E. Johansson (Aktiebolaget Atomenergi, Stockholm). p.305-42 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

The material buckling of various lattices in the exponential (ZEBRA) and the critical (RO) facilities, resonance integrals of various fuel geometries and materials, and neutron spectra with a fast chopper are discussed. In the exponential experiments, a leakage effect was found. The leakage results in a background that introduces systematic errors when changes in the radial buckling are estimated purely by theoretical calculations. In the critical facility the progressive substitution technique was extensively used. A modified one-group perturbation theory combined with a new cell definition is found to be a powerful tool for the interpretation of substitution experiments. A summary of the work on resonance integrals is given together with a discussion of factors limiting the experimental accuracy. The neutron spectrum in the central channel of the reactor R1, where the resonance integrals were studied, was subject to detailed investigations with a fast chopper. The energy range extended from 0.02 ev up to about 10 kev. (auth)

6455 FINE DISTRIBUTIONS IN CLUSTERS FOR METAL URANIUM; HEAVY WATER, GAS-COOLED REACTORS. J. P. Schneeberger, B. Gloor, J. Marti, E. Perpignani, W. Heer, F. Hegedues, and H. Lutz. p.343-69 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963. (In French)

Measurements of fine thermal flux distributions in clusters for uranium, heavy water, gas-cooled reactors were recently made in the EIR subcritical assembly at Würenlingen. Four cluster variants (mock-ups) were studied. The flux gradient in the peripheral rods, the thermal utilization (f), and the equivalent absorption section of the Σ_a cell were determined. The epithermal component of the neutron flux in the cell is also given. The interpretation of the results led to the following conclusions: (1) The homogenization of the clusters in concentric rings overestimates the factor (f). For a typical, 7-rod cluster the deviation is 6%. The local flux dip in the peripheral rods reproduces badly. (2) Good agreement with the experimental values is obtained by synthesis of the two P_3 calculations in cylindrical geometry. The model gives a good reproduction of the fine distribution in the rods. (auth)

6456 A THEORETICAL INTERPRETATION OF THE PRESSURE-TUBE, HEAVY-WATER, ZERO-ENERGY EXPERIMENT IN DIMPLE. D. A. Newmarch (Atomic Energy Establishment, Winfrith, Dorset, Eng.). p.445-502 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963. (AEEW-R-187)

An analysis is made of the lattice physics measurements performed in DIMPLE during 1960 to 61 on pressure-tube, heavy-water cores with various coolants in the pressure tube. The experimental reactivities and reaction rates are compared with Carlson S_n and Monte Carlo calculations in order to reveal any discrepancies between experiment and basic theory. Predictions of the Winfrith five-group scheme were compared with experiment and the more sophisticated theories. It is shown that agreement between this simple method and experiment is to some extent fortuitous and results from errors canceling each other. (auth)

6457 BSQ, AN IBM-704 CODE TO CALCULATE HEAVY WATER LATTICE PARAMETERS. F. E. Driggers (E. I. du Pont de Nemours & Co., Aiken, S. C.). p.551-72 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

A code is described that is used at the Savannah River Laboratory to calculate the buckling and other lattice parameters of D_2O-moderated lattices. A comparison is made of calculated and measured bucklings for a variety of lattices. Two adjustments are made in the calculations to improve the agreement. The amount of resonance absorption is reduced by about five percent for lattices containing uranium metal and the value of η is assumed to be a linear function of the ratio of moderator volume to fuel volume and both of the coefficients in this expression are adjusted. The agreement between measured and calculated bucklings is within ± 0.25 m^{-2} for almost all of the lattices of single rods or of tubes and is within ± 0.50 m^{-2} for almost all of the lattices of rod clusters. (auth)

6458 A TECHNIQUE FOR PHYSICAL COMPUTATIONS OF NATURAL-URANIUM, HEAVY-WATER REACTORS AND A REVIEW OF CERTAIN EXPERIMENTAL AND THEORETICAL STUDIES. P. P. Blagovolin (Inst. of Theoretical and Experimental Physics, Moscow). p.581-98 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963. (In Russian)

The calculation of material buckling in a cold critical assembly is considered in detail. The technique is extremely simple, permitting rapid calculation without computers. In the calculation of η allowance is made for deviation of the U^{235} absorption cross section from the law 1/v as a function of the assumed neutron temperature in the uranium. The ϵ value is calculated on the hypothesis that a fast neutron leaving the uranium lump cannot cross the U^{238} fission threshold, i.e., causes no additional fissions in the original and neighboring lumps. It is considered that elastic scattering in the lump does not alter the neutron energy but that inelastic scattering disappears immediately at the fission threshold. Should hydrogen be present in the lump the elastic scattering cross section is formally regarded as inelastic. To calculate φ (or p) the well-known semiempirical formula of Gurevich and Pomeranchuk, with Hellstrand's constants, is employed; their corrections are also used in the case of rod clusters or annular assemblies. In K_∞ a fifth factor (μ) is introduced which takes account of neutron increase and capture during slowing down (epithermal region). In computing this factor account is taken of the resonance integrals of all absorbing substances, the neutron field accordingly being regarded as uniform. Computation of θ (or f): in a strongly-absorbent fuel element, the calculation is made by the Amouyal-Benoist nonscattering method. Should thermal neutron formation in the fuel element be small, a correction is made for scattering. Differences in neutron density in the gaps and in the walls in which the scattering capacity is low are calculated by means of an empirical formula. Neutron density variations

in strongly scattering layers are calculated by a simple scattering formula but an empirical coefficient taken from experiment or from a complicated nonscattering calculation is introduced. The neutron field in the moderator is calculated by a scattering formula, absorption in the moderator being taken as equal to zero, and corrected for nonscattering in the vicinity of the fuel element. For each region, the problem is solved for one energy value only but neutron velocity may be considered different in the various regions. Thus in a uranium fuel element the neutron velocity taken generally corresponds to the mean neutron velocity in the Maxwellian distribution, with an absolute temperature approximately 30% above moderator temperature. The excess temperature in individual cases may be corrected by experimental data or by complicated calculations which take full account of thermalization. The value L^2 is generally computed without taking anisotropical scattering into account, using the θ data, and allowing for neutron temperature in the moderator. The value of τ for mixtures of different substances are calculated according to the experimental τ values for the separate substances. A simple formula was developed on the assumption that τ is proportional to the lethargy. Correction is made for the inelastic collision of fast neutrons leaving the fuel element. (auth)

6459 SYSTEM ANALYSIS OF NUCLEAR REACTOR DYNAMICS. An AEC Monograph. Lynn E. Weaver (Univ. of Arizona, Tucson). Monograph Series on Nuclear Science and Technology. New York, Rowman and Littlefield, Inc., 1963. 294p. $6.95(Library Binding).

Concepts of linear system analysis are presented and their applications to studies of the stability and dynamic behavior of fundamental reactor systems are shown. General examples are given. Topics covered include: complex-plane transformations; system components and system design; kinetic equations; feedback analysis and nuclear-system analysis; analog simulation; and statistical control theory. (T.F.H.)

Design and Feasibility

6460 (JPL-TR-32-512) CRITICALITY CALCULATIONS FOR A FAST LIQUID-METAL-COOLED REACTOR— PHASE I. H. G. Gronroos (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Nov. 15, 1963. Contract NAS 7-100. 26p.

Multigroup diffusion theory calculations were employed to evaluate some static reactor physical properties for a conceptual fast liquid-metal-cooled reactor. Also, the influence of the constructional components on reactivity was investigated. It is concluded that the reactor concept holds promise in fulfilling the requirements of 20,000 hr of operation at 10 Mw thermal power with reflector control, provided 45,000 Mwd/t burnup can be achieved with a uranium refractory and lithium fuel slurry at 2700°F peak fuel temperature. (auth)

6461 (NP-13442) OB ODNOM METODE ISSLEDOVANIYA KIPENIYA ANALIZOM FLYUKTYATSII VYZVANNYKH V REAKTORE. (On a Method for Investigation of Boiling by an Analysis of Fluctuations Induced in a Reactor). I. Iftode, A. Mikheile, I. Purika, Kh. Poshu, and D. Stoyan (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). Apr. 1963. 11p.

Both boiling-water and pressurized-water type reactors require knowledge of the boiling of the water; in particular, the power changes made under various conditions of boiling and regions of steady-state operation must be determined. Formation of bubbles in the reactor is equivalent to a point disturbance creating a certain reactivity, the position of which varies with time. The boiling is detected on the basis of the average thermal flux, the temperature, and the vapor content of the water. The reactor may be considered a specific instrument that makes it possible to measure the fluctuation of vapor bubbles by determining the frequency spectrum of the neutron flux fluctuations. Such measurements were carried out on the VVR-S reactor using an electrically heated Al tube passing through the core. As the macroscopic absorption cross-section values of Al and H_2O are close, the observed effect is due to the fact that the scattering cross section of H_2O is 41 times higher. A resonance was observed between the frequencies of 0.2 to 0.25 herz and about 1.5 herz. The average square amplitude of the fluctuation of the reactor is only 2% of the value induced by boiling and therefore may be neglected. (TTT)

6462 (ORNL-3499(Vol.I)(p.93-7)) MEASURED GAMMA-RAY SPECTRA FROM A STAINLESS STEEL REACTOR: STATUS REPORT. G. T. Chapman, K. M. Henry, J. D. Jarrard, and R. L. Cowperthwaite (Oak Ridge National Lab., Tenn.).

Previously measured pulse-height spectra of gamma rays emitted by a stainless steel reactor core were studied to identify the sources contributing to the observed spectral structure. (auth)

6463 BASIC PHYSICS OF FAST REACTORS. Ferenc Szabo (Central Research Inst. for Physics, Budapest). Magy. Fiz. Folyoirat, 11: 325-49(1963).

Breeding reactions, breeding factors in thermal reactors, possibilities of breeding at various neutron energies, general principles of construction and operation for fast reactors, criticality in fast multiplier systems, neutron energy spectra in fast reactors, properties of systems comprising different types of reacting materials, effects of non-fissionable substances on reactivity, kinetics, control, safety factors, and other aspects pertaining to fast reactors are discussed. Twenty-one references, including 1 German and 20 Western, are given. (OTS)

6464 NUCLEAR REACTOR, THE CORE OF WHICH CONTAINS A CHARGE OF FUEL ELEMENTS CONSISTING OF SHAPED BODIES, SUCH AS BALLS. (to Brown, Boveri & Cie AG and Beteiligungs-und Patentverwal-Tungsgesellschaft mir Beschrankter Haftung). British Patent 938,120. Oct. 2, 1963. Priority date Aug. 27, 1959, Germany.

The core of the reactor considered contains a charge of fuel elements consisting of shaped bodies cooled by a coolant flowing upwardly through the charge. The horizontal cross sectional area of the core filled with the charge widens continuously in the upward direction according to the changing average temperatures of the coolant at various levels, so that a constant velocity of flow of the coolant throughout the core is obtained. With constant velocity of the gas flowing through, the uppermost layer of fuel elements will not be lifted. (A.G.W.)

6465 REACTOR OF THE BOILING WATER TYPE ASSOCIATED WITH AT LEAST ONE STEAM TURBINE. Pierre H. Facault (to Société Francaise des Constructions Babcock & Wilcox). German Patent 1,153,466. Aug. 29, 1963. Priority date Jan. 17, 1958, France.

The reactor described is subdivided by an inner partition into two steam-generating compartments enclosing corresponding sections of the reactor core. The second compartment feeds the turbine with driving steam and receives in return from the latter its feed water through the agency of the condensing means inside which the steam produced in the first compartment is condensed in a sub-

stantially complete manner in contact with the feed water while water-purifying means are inserted in parallel with the circuit including the first compartment and condensing means. By this arrangement, the water contained in the second compartment is subjected to a continuous draining and the steam feeding the turbine benefits by a lowering of the concentration of impurities. (Gmelin Inst.)

6466 HIGH TEMPERATURE NUCLEAR REACTOR. Herbert Barth and Rudolf Schulten (to Brown, Boveri & Cie, AG and Beteiligungs- und Patentverwaltungsgesellschaft mbH). German Patent 1,154,882. Sept. 26, 1963. Filed July 30, 1959.

In applications in which low weight and limited space requirements of the reactor plant are essential, high-temperature nuclear reactors are useful. In these plants the heat exchanger and the secondary circuit are dispensed with, and the gas escaping from the reactor core is used directly for driving a gas turbine. A device which obtains its energy from a high-temperature nuclear reactor is made independent of further auxiliary sources of energy, such as the source of energy for the starting engine of a gas turbine. The high-temperature nuclear reactor is provided with a cooling-gas circuit that serves essentially for the removal of useful heat, and a second circuit that is fed with water and may be operated temporarily or continuously independently of the circulated cooling gas. (Gmelin Inst.)

6467 APPARATUS FOR MEASURING THE POWER LEVEL OF HEAVY OR LIGHT WATER MODERATED NUCLEAR REACTORS. Alan J. Salmon (to Associated Electrical Industries Ltd.). German Patent 1,156,904. Nov. 7, 1963. Priority date June 11, 1959, Great Britain.

The apparatus described utilizes Cherenkov radiation generated by beta particles in the moderator for measuring and/or monitoring the power developed in a reactor. This apparatus comprises a transparent light pipe, which is arranged so that the light generated by the Cherenkov effect is transmitted from the moderator within the reactor vessel to a photoelectric device outside the reactor shielding. The light pipe is bent at least twice, so that no nuclear radiation can escape along it. (Gmelin Inst.)

6468 NUCLEAR REACTORS. Stanley Hackney (to United Kingdom Atomic Energy Authority). U. S. Patent 3,105,032. Sept. 24, 1963. Priority date Sept. 1, 1958, Great Britain.

The reactor considered operates on the principle of extended periods of fuel burn-up between charge and discharge and has no charge-discharge machine permanently in position. Access tubes extending through the pressure vessel and shielding contain a shield plug in each access tube. The shield plug associated with each fuel-element channel is connected to the fuel-element train in such a manner that withdrawal of the shield plug causes partial withdrawal of the fuel-element train from the reactor. Withdrawal may be effected by pressure-operated means associated with a cap connectable to and forming an extension of the access tube. The extension contains a slidable piston that operates to withdraw the shield plug and a locking mechanism to hold the plug in its partially withdrawn position. In this position the fuel elements are contained partly within the neutron shield and partly within the corresponding access tube and its extended portion. Provision is made for maintaining coolant flow over the partly withdrawn fuel elements. (A.G.W.)

6469 BOILING NEUTRONIC REACTOR SYSTEMS. W. E. Abbott (to Westinghouse Electric Corp.). U. S. Patent 3,113,916. Dec. 10, 1963. Filed Sept. 27, 1957.

A boiling reactor of the homogeneous or quasi-homogeneous kind is described which prevents the development of hot spots in the core and the need for extensive biological shielding. The homogeneous fuel solution is entirely confined to the reactor core vessel, and the coolant portion of the solution comprises a mixture of miscible higher and lower boiling liquids, wherein the lower boiling component is vaporized to form the working fluid while the higher boiling component remains in liquid form to prevent hot spots. In one example, the higher boiling component is water, while the lower boiling component could be an alcohol or ether. The reactor could also be adapted to the heterogeneous kind. (D.L.C.)

Fuels

Refer also to abstract 5730.

6470 (GA-4624) COMPARISON OF PARTIAL ROUGHENING OF THE SURFACE OF FUEL ELEMENTS WITH OTHER WAYS OF IMPROVING PERFORMANCE OF GAS COOLED NUCLEAR REACTORS. G. B. Melese (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 30, 1963. Contract AT(04-3)-187. 113p.

By properly roughening the surface of fuel elements in a gas-cooled nuclear reactor, the temperature drop between the surface and the coolant may be halved. The corresponding friction pressure drop is approximately doubled if only the downflow part of the fuel element is roughened. The total pressure drop in the reactor is usually only increased by 10 to 20%. Using this improvement in surface heat transfer coefficient, maximum internal and surface fuel temperatures could be decreased, coolant temperatures could be raised, and over-all pressure drop could be decreased by decreasing the mass flow or increasing the flow area. Also the power density could be increased, or the total number of fuel elements could be decreased. Similar improvements in reactor performance could be obtained with smooth rods but in a less efficient way. For instance, the number of fuel elements of given length and total volume could be decreased by a factor of 4 by doubling the rod diameter with either roughened or smooth elements. Total reactor power, maximum surface temperature, and coolant temperatures are assumed to be fixed. The pressure drop remains constant with partially roughened fuel elements, while the friction pressure drop in the core is multiplied by 4 for smooth elements, since the flow area per channel is only doubled in order to maintain the proper temperatures, while it was quadrupled for roughened elements. The decrease in number of rods is obviously smaller when the internal fuel temperature is limiting, but the core friction pressure drop is smaller with partially roughened rods than with smooth rods. A large number of cases were studied and it was concluded that properly partially roughened fuel elements are always preferable to smooth elements from the viewpoint of overall performance. (auth)

6471 (NP-13445) O VOZMOZHNOSTI OBNARUZHENIYA POYAVLENIYA NEHERMETICHNOSTI OBOLOCHKI T.V.E. IZ REAKTORA METODOM IZMERENIYA AKTIVNOSTI VODY PERVICHNOGO KONTURA. (On the Possibility of Discovering Leakage in Reactor TVE Jacket by Measuring First Cycle Water Activity). E. Ionesku, Z. Aleksan, and I. Purika (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). Apr. 1963. 11p.

The possibility of detecting a leak in the jacket of a water-cooled reactor fuel element by determining the gamma spectrum and analyzing the beta activity in the first-cycle coolant was indicated. Different amounts of ir-

radiated and nonirradiated uranyl nitrate were added to the water at different times and the gamma spectrum was studied with a 400-channel analyzer and the beta spectrum was determined by absorption in an Al end-window counter. The beta energy from the nonirradiated uranyl nitrate was between 1.6 and 1.7 Mev, and the gamma spectrum had a peak between 0.08 and 0.15 Mev. The irradiated material had two beta energies, between 0.3 and 0.04 Mev and possibly at 1.3 Mev. The gamma had a well-defined peak at 0.08 to 0.15 Mev and two less well defined peaks with energies of 0.22 and 0.3 Mev. Two half lives, of 2.3 to 2.5 and 50 days, were measured. The 2.3 to 2.5-day half life and the 0.3 to 0.4-Mev beta shows the presence of Np^{239}, from beta decay of U^{239}, in turn resulting from a (n,γ) reaction on U^{238}. Analysis of the first-cycle water showed no 2.3-day activity, and its gamma spectrum showed peaks corresponding to the corrosion products Na^{24}, Co^{60}, and Fe^{59}. The gamma spectrum from the water with added uranyl nitrate showed a peak between 0.08 and 0.15, indicating U^{235}. With 1.5×10^{-4} mg of uranyl nitrate per liter, this peak was twice as large as that from normal radioactive background in the water after 2000 kw operation. (TTT)

6472 (NP-13446) DOPOLNITEL'NYE DANNYE OTNOSITEL'NO VYGORANIYA TOPLIVA V REAKTOPE VVRS-IAF BUKHAREST. (Additional Data on Fuel B Burn Up in WWRC-IAF Bucharest Reactor). I. Udrya and L. Mentesku (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Apr. 1963. 7p.

The burnup in each of the fuel element groups of the reactor was estimated by making use of the perturbation theory; the measurements included the determination of the statistical weight of each group and the change of the reactivity caused by the replacement of that group of fuel elements with a fresh unit. The perturbation theory may be used in this case because the condition $\delta k_{eff} \ll 4(k_{eff} - 1)$, i.e., $4 \cdot 10^{-2} \ll 4(1.03 - 1)$, (where δk_{eff} designates the change of the effective multiplication factor k_{eff} when the partially burned-up fuel is replaced with fresh material) is satisfied even for the central unit. The calculations showed that the average flux in the fission products is equal to the average flux in the fuel. In case of a total burnup of 11200 Mwday/ton, the burnup in the central group was found to exceed that in the peripheral groups by a factor of about 2. The method was found to be fast and convenient to use and will be employed in the future for burnout measurements. (TTT)

6473 (TID-19821) NONDESTRUCTIVE ASSAY OF NUCLEAR FUELS. Quarterly Report No. 1, August 15, 1963–November 15, 1963. Warren J. McGonnagle (Southwest Research Inst., San Antonio). Nov. 22, 1963. Contract AT(11-1)-1321. 14p.

A research program is being conducted to determine the feasibility of using a modified Compton magnetic spectrometer for analyzing the uranium and plutonium content of cold and irradiated nuclear fuels, to evaluate the use of solid-state detectors in gamma spectrometry for both cold and irradiated nuclear fuels, and to devise methods and techniques for determining the special material content of scrap. The primary effort during this period has been a literature search. The literature search has been concerned with (1) studying pertinent papers on the Compton magnetic spectrometer and (2) studying pertinent papers on solid state detectors and their application to the measurement of gamma radiation. (auth)

6474 RADIOCHEMICAL STUDIES ON FUEL SAMPLES OF THE DRAGON HIGH-TEMPERATURE REACTOR EXPERIMENTS. H. R. von Gunten and A. Wyttenbach (EIR, Wurenlingen, Ger.). Neue Tech., 5: 551-4(Sept. 1963). (In German)

The methods worked out for the study of Dragon fuel samples in the EIR hot laboratory are briefly described. Burn-up determinations and diffusion of fission products are discussed. The radiochemical and counting methods and techniques are reviewed. (J.S.R.)

6475 THERMOMECHANICAL TESTING OF FUEL ELEMENTS USED IN A GAS–GRAPHITE NATURAL URANIUM REACTOR. G. Grassi and C. Tribuno. Termotecnica (Milan), 17: 517-27(1963). (In Italian)

Four methods used for the mechanical testing of "polyzonal" fuel elements, consisting of a uranium rod with a diameter of 30 mm and a length of 900 mm, hermetically soldered in a Mg alloy container with a spacing of 2 mm, are described. The testing methods considered are the end-cap push-off method, thermal shock method, thermal cycling method, and viscous flow or endurance method. (J.S.R.)

6476 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Stefan George Bauer and Norman Battle (to Rolls-Royce Ltd.). British Patent 937,660. Sept. 25, 1963. Filed July 10, 1959.

The fuel element described comprises a tubular metal casing in which a large number of basically cylindrical pellets of fissile material are disposed in end to end abutment. Each pellet has a main cylindrical surface portion of such diameter that the pellet is a slack fit in the casing and reduced-dimension end surface portions of curved or tapered form such that an annular channel is formed between the pellets and the casing. After the pellets are inserted and the ends are closed by stainless steel plugs, the casing is deformed into the channels by subjecting it to an external fluid pressure of about 6000 psi. The pellets are thus located axially in the casing and good heat transfer is provided. (A.G.W.)

6477 IMPROVEMENTS IN AND RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Hugo Heinrich Ludolf Ritz (to C. A. Parsons and Co. Ltd.). British Patent 937,673. Sept. 25, 1963. Filed Nov. 21, 1960.

The fuel element described includes a plurality of tubular containers housing nuclear fuel located in an enclosing tube or a bore in a reactor core. The containers have their longitudinal axes substantially parallel to one another and to the axis of the enclosing tube. The outer surface of each container has fins helically disposed with respect to the longitudinal axis of the container. Baffles extending in the direction of the longitudinal axes of the containers intersect the fins on the containers to baffle the flow between the fins. The baffles extend between the containers and the wall of the enclosing tube to provide a plurality of separate flow channels through the tube. This arrangement produces vortex motion of the cooling fluid over substantially the whole length of the containers. (A.G.W.)

6478 IMPROVEMENTS IN AND RELATING TO CONTACT BOXES FOR NUCLEAR REACTORS. Ian Laird McKenzie Paterson (to Nuclear Power Plant Co. Ltd.). British Patent 938,296. Oct. 2, 1963. Filed Mar. 27, 1961.

Means are described for locating a removable part of a thermocouple contact box with respect to a fixed part of the box in a nuclear reactor after the two parts have been separated. One part of the contact box is fixed in a tubular locating member having a portion extending beyond the box part to contact the other part of the contact box before the two parts are joined. The extending portion is cut away in at least one plane at an angle inclined to the axis of the lo-

cating member to form a pointed nose on the member. A key is provided in the fixed part of the contact box and a keyway in the locating member. The shape of the cut-away portion is such that, if the key and keyway are not aligned as the nose of the locating member contacts the key, the locating member is rotated upon further movement of the parts toward one another until the key and keyway are aligned. (A.G.W.)

6479 FUEL ELEMENT WITH BURNABLE POISON WITHIN THE CLADDING. John F. Mumm (to The Babcock and Wilcox Co.). U. S. Patent 3,103,476. Sept. 10, 1963. Filed Dec. 2, 1958.

A nuclear fuel element is proposed, in which the cladding encasing the fissionable material contains 200 to 1000 ppm of natural boron. The boron is homogeneously distributed throughout the cladding and acts as a burnable poison to control long-term excess reactivity. (A.G.W.)

6480 METHOD OF EQUIPPING A NUCLEAR REACTOR FUEL ELEMENT WITH A THERMOCOUPLE. Piyatilleke Perera Guneratne (to United Kingdom Atomic Energy Authority). U. S. Patent 3,104,215. Sept. 17, 1963. Priority date Mar. 15, 1957, Great Britain.

In the method described for equipping a nuclear fuel element with a thermocouple, a thermocouple junction and the adjacent part of its associated stainless-steel sheathed cable are covered with either Nb or Ta. A uranium fuel member is then fabricated about the junction and part of the covered cable so that the uncovered part of the cable extends beyond the fuel member. The fabricated fuel member is then enclosed in the fuel element sheath and a seal is provided where the cable passes through the sheath. (A.G.W.)

6481 FUEL ELEMENTS FOR NUCLEAR REACTORS. Peter Sulzer (to Sulzer Freres, S.A.). U. S. Patent 3,104,219. Sept. 17, 1963. Priority date Nov. 1, 1957, Switzerland.

A canned unitary fuel element assembly contains a central inner fuel rod of U^{233}-enriched material surrounded by a multi-tube envelope consisting of a plurality of hollow tubular outer fuel rods of natural U. The outer fuel rods are circumferentially disposed in longitudinal contact with each other about the center fuel rod. Means are provided for coolant flow through the assembly. (A.G.W.)

6482 NUCLEAR REACTOR AND THERMIONIC FUEL ELEMENT THEREFOR. N. S. Rasor and Robert L. Hirsch (to U. S. Atomic Energy Commission). U. S. Patent 3,113,091. Dec. 3, 1963.

The patent relates to the direct conversion of fission heat to electricity by use of thermionic plasma diodes having fissionable material cathodes, said diodes arranged to form a critical mass in a nuclear reactor. The patent describes a fuel element comprising a plurality of diodes each having a fissionable material cathode, an anode around said cathode, and an ionizable gas therebetween. Provision is made for flowing the gas and current serially through the diodes. (AEC)

Power and Power-Breeder Reactors

6483 (APDA-156) DESIGN AND ECONOMIC EVALUATION OF FIXED BLANKETS FOR FAST REACTORS. A. E. Klickman, G. L. Ball, J. J. Edwards, W. H. Jens, B. M. Segal, R. E. L. Stanford, and R. C. Williams (Atomic Power Development Associates, Inc., Detroit). Aug. 30, 1963. Contract AT(11-1)-865. 62p.

As a part of an over-all evaluation of advanced blanket concepts for fast reactors, a study has been made of fixed blankets. This study has taken into account the engineering, physics, and economics of a typical alloy (U – 3 wt % Mo) blanket and a typical oxide (UO_2) blanket. For both blankets, the material was considered to be in the form of pins or rods, and a design was established that would optimize the economics for a set of engineering and economic ground rules consistent for the two designs and reasonable in terms of present-day technology. The conclusion resulting from the study is that a well-designed oxide blanket offers many economic advantages over a well-designed alloy blanket. For the reference core selected in this study, it was found, for best economics, that of each of the two blanket types considered each blanket should contain about the same amount of uranium. However, it was found also that the oxide blanket should be 40 cm thick and the alloy blanket 20 cm thick. Then both blankets would have about the same flux attenuation and neutron absorption characteristics, and about the same breeding ratio. However, the assumed burnup limitations of 5000 Mwd/MTU on the alloy and 25,000 Mwd/MTU on the oxide severely limit the alloy in achieving its economic potential, but they do not seriously affect the economic achievement of the oxide. However, even if these burnup limitations were disregarded, the economics of the oxide would still be better than the economics of the alloy. In this study it was found that it is economically profitable to zone a blanket; i.e., each annular region should consist of subassemblies with pins appropriate to that region. This permits the use of low-cost, large-diameter pins in the outer regions of the blanket. From the physics studies performed, it was found that heat, specifically heat from Pu^{239} fissions, is an important product of the blanket. Because plutonium builds up when a blanket subassembly is in the reactor, the heat produced and the plutonium concentration vary with time as well as space. In considering blanket lifetimes for which economics could be optimized, it was found that the geometric maximum-to-average values for burnup and heat generation rate in any given annular region would be about 2 at the beginning of life and about 6 at the end of life because of plutonium buildup. The length of time required to achieve optimum economics vary from 1.7 years and 3.4 years in the inner zone to about 4.2 years and 7.5 years in the outer zone of the alloy and oxide blankets respectively. These are reasonable lifetimes with respect to material and corrosion limitations and with respect to reactor operating procedures. Basically this study has shown that economic blankets can be designed for present-day prices and that the economics of an oxide blanket are better than the economics of an alloy blanket. Furthermore, there is an economic advantage to the use of good design practices whereas there is little if any economic advantage to procedures such as moving a subassembly inward during its lifetime, which is one method that has been suggested for use in blanket operation. (auth)

6484 (CONF-243-37) TRAINING OF CONSUMERS PUBLIC POWER DISTRICT PERSONNEL FOR THE OPERATION OF THE HALLAM NUCLEAR POWER FACILITY. J. S. Loomis (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [nd]. Contract AT(11-1)-Gen-8. 18p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

Sheldon Station employees of the Consumers Public Power District (CPPD) attended a formalized training

program on the HNPF during 1960 while the facility was under construction. The program was conducted and developed by Atomics International and was of six months duration. Total instruction time for this program was approximately 900 hours. Thirty CPPD personnel attended. A second HNPF training program for CPPD personnel was initiated by AI in September 1961. This program was primarily intended to train HNPF reactor operators. After completion of the training program, trainees took AEC reactor operator license examinations. This program was carried out in three sessions. The first session began in September 1961, and the third session was completed in February 1963. Thirty CPPD and 22 AI personnel were trained and, after passing the AEC examinations, received HNPF reactor operator licenses. The two formalized HNPF training programs were entirely independent of on-the-job training activities. These activities have been extensive. The conventional portion of Sheldon Station has been a commercial power plant since July 1, 1961. All station operating personnel are thoroughly familiar with conventional power plant operation. Most operating personnel had considerable conventional power plant experience prior to employment at Sheldon Station; those who did not were trained in power plant operation by CPPD management. All shift operating personnel have been regularly rotated between conventional and nuclear sides of the facility and are, as a result of experience, familiar with both. Sheldon Station CPPD personnel were utilized extensively as instructors for the two formalized HNPF training programs and as responsible engineers for numerous tests of the HNPF. CPPD shift personnel constituted the principal operating force throughout HNPF construction, reactor startup, and testing. (auth)

6485 (DLCS-3570108) REACTOR PLANT CONTAINER INTEGRITY TEST (AIR LOCK TEST). Core 1, Seed 4. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, June 28, 1963, Second Issue, Oct. 24, 1963. Contract [AT(11-1)-292]. 9p.

The purpose of a particular reactor plant container integrity test (air-lock test) is to prove the integrity of each of six air locks by means of an air pressure test, visual inspection, and operating check. Air lock number one maintained the required integrity with a minimum of maintenance and allowed hand wheel operation with one third the torque required by the other air locks maintaining the same integrity. Airlock number one is equipped with mechanical seals on all shaft penetrations whereas all other air locks use packing glands. The data do not indicate that increased air lock integrity results from lubrication of the door gaskets. Three failures of the airlock door gasket "popping" mechanism were observed. These failures were caused by pressure regulators that were contaminated by oil and foreign particles. (auth)

6486 (DLCS-4140101) REACTOR PLANT COOLDOWN AND TEMPERATURE CONTROL SYSTEM PERFORMANCE. Test Evaluation. Richard J. McKee (Duquesne Light Co., Shippingport, Penna.). First Issue, Oct. 1, 1963. Contract [AT(11-1)-292]. 12p.

The purpose of this test was to obtain information on the performance of the cooldown system, using various methods of control. It was possible to cooldown an isolated reactor coolant loop using this system; however, control was extremely difficult, especially when the system was condensing steam. The cooldown rates were considerably less than design values. (auth)

6487 (EUR-468.i) STUDIO PRELIMINARE DEGLI EFFETTI ECONOMICI DELL'INSERIMENTO IN RETE DI CENTRALI NUCLEARI DI POTENZA. (Preliminary Study of the Economic Effects of Incorporating Nuclear Power Plants in a Grid). (Italy. Comitato Nazionale per l'Energie Nucleare, Rome). 1963. 160p.

The results obtained by simulating the coordinated economic operation of a combined hydro- and thermoelectric grid are presented and analyzed, and the part that nuclear power plants can play in such a grid is described. (auth)

6488 (HPR-32) HBWR QUARTERLY PROGRESS REPORT, JULY TO SEPTEMBER 1963. (Norway, Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). 144p.

The reactor was shut down for the installation of the equipment for the water chemistry experiments and general maintenance. During operation a series of dynamics experiments was carried out, consisting of the following experiments: automatic control of the vessel pressure, reactivity oscillator experiments, nonlinear reactivity perturbation, preliminary steam load variation experiment, dynamics measurements with digital perturbations, noise measurements, and study of the influence of the introduced reactivity perturbations on reactor stability. Considerable effort was made to detect leakages. Fission product contamination was measured and evaluated. Other activities included: installing a special void element and removing the modified first charge spike element, reevaluation of temperature reactivity effects in the first fuel charge, analysis of differential void reactivity in NORA and HBWR, analysis of control rod experiments, application of GIER computer to dynamic experiments, fabrication and development of fourth instrumented fuel assembly (IFA-4), in-core instrument development, measurement of central oxide temperature in IFA-3, and evaluation of proposed water chemistry program. (N.W.R.)

6489 (LADC-6093) GAS-BEARING BLOWER MANUFACTURED BY SOCIETE RATEAU FOR THE ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT. W. E. Crowe (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 6p. (CONF-251-4)

From Rotating Machinery for Gas Cooled Reactor Application, Gatlinburg, Tenn., Nov. 1963.

Design features are given for a helium blower operating on hydrodynamic gas bearings, manufactured for use in the Ultra-High Temperature Reactor Experiment. With inlet helium at 495 psi and 100°F, the blower is designed to produce a pressure rise of 15 psi at a flow rate of 120 lb/hr. (T.F.H.)

6490 (MND-2903(Vol.II)) FEASIBILITY STUDY OF WATER-COOLED THERMIONIC NUCLEAR POWER PLANT. (Martin-Marietta Corp. Aerospace Div., Baltimore). Nov. 1962. Contract AT(30-1)-2990. 118p.

A description is given of a development program recommended to permit design and construction of a water-cooled thermionic plant. The entire program is divided into five areas: in-core diode development, both fuel-element and thermionic-diode; plant component development; critical experiments, both hot and cold; electrical converter; and engineering. The schedule, cost, scope, manpower, and facilities are defined for each of these five areas. The interrelations between programs and the applicability of each program to the design is shown. (auth)

6491 (NAA-SR-7880) DESIGN AND DEVELOPMENT OF THE SAFETY-ROD DROP-TIME TEST SYSTEM. J. G. Radcliff (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 31, 1963. Contract AT(11-1)-Gen-8. 16p.

The SRE safety-rod drop-time system consists of elec-

tronic time-interval meters and magnetic pickups to measure free-fall drop time and snubbing time of the safety-rod poison elements prior to all normal reactor start-ups. The electronic timing system is panel mounted in the reactor control room. The snubber time and free-fall time are displayed on four-decade lighted dials on the two timers and are read directly in units of time. The complete drop-time measurements can be made at the test panel by one individual in less than ten minutes. The timing system was developed to provide a rapid time-measurement technique to check for obstructions to free-fall and to measure snubber wear. (auth)

6492 (NYO-10398) REPORT ON THE DESIGN STUDY OF FLUID ENGINE POWER SYSTEMS. C. H. Baker, R. S. Pauliukonis, T. A. Hunter, and A. V. Pradhan (Cleveland Pneumatic Tool Co.). Apr. 12, 1963. Contract AT(30-1)-3022. 288p.

Information generated during a six month feasibility study of an engine which uses a supercritical working fluid as the secondary portion of nuclear powered electric generating system is presented. Detailed analysis of the PM-2A secondary system showed significant cost, weight, and size reductions to be possible by conversion to the supercritical engine. Similar analysis of the ML-1 secondary system showed a significant efficiency improvement, but this is offset by increased cost, a 10% increase in weight, and essentially the same volume. Thermodynamic operating principles are given, and details of operation of the supercritical fluid engine are described. Technical results of investigations into the problems of heat transfer at high pressures and background information on supercritical thermodynamics are presented. Preliminary design layouts of two sizes of engines are included by reference and the basic parameters for a wide range of heat exchangers and engines are discussed. (auth)

6493 (SRO-96) HEAVY WATER POWER REACTOR PROGRAM. Monthly Progress Report. (Savannah River Operations Office, AEC). Nov. 1963. 11p.

Research and development progress is reported on the AEC-AECL cooperative program, CANDU boiler, SAP testing, nondestructive tests, fluid dynamics and heat transfer for fuel elements, zirconium technology, reactor coolant testing, Deuterium-Moderated Demonstration Converter Reactor development, power reactor development, Heavy Water Components Test Reactor operation, and Carolinas-Virginia Tube Reactor development and operation. (N.W.R.)

6494 (UNC-5054) REVIEW AND EVALUATION OF TEMPERATURE-INDUCED FEEDBACK MECHANISMS IN FAST POWER REACTORS. F. R. Nakache (United Nuclear Corp. Development Div., White Plains, N. Y.). Apr. 1, 1963. Contract AT(30-1)-2832. 102p.

The interrelation between multiplication, power, heat transfer characteristics, and temperature distributions is discussed and the reactivity coefficients typical of given physical conditions of a reactor are defined. Temperature-induced mechanisms that cause reactivity changes are described and the considerations concerning the evaluation of the reactivity effects are illustrated by some simple examples. The methods of predicting reactivity coefficients, the experimental situation, and the approach to theoretical calculations are also discussed. The magnitude of the feedback contribution of individual mechanisms is listed for each existing reactor. The relative magnitudes of the feedbacks are compared, reasons for their differences are discussed, and important or unique characteristics are pointed out. Some fast reactor concepts being given serious consideration are also discussed briefly. 135 references. (auth)

6495 METALLURGICAL CONSIDERATIONS ON A BREEDING REACTOR WITH LIQUID THORIUM ALLOY. Richard M. Bidwell (Instituto de Energia Atomica, Sao Paulo, Brazil). ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo), 19: 557-69(1963). (IEA-65). (In Spanish)

The necessity of breeding reactors in order to utilize, for the most part, the resources of Brazil in nuclear fuel is discussed. The advantages of moving or circulating fuels are explained. Sketches of the fertile zone and the reactor core are given for a reactor for the production of U^{233} from Th, fueled by Pu. It is proposed that this reactor be run in conjunction with another reactor fueled with U^{233} that produces Pu. It is shown that with the use of a fused Pu alloy driven by liquid Na in an exterior ring the fission products can be removed, so that the greater part of the fuel can be used without reprocessing. (tr-auth)

6496 PREVIOUS OPERATING EXPERIENCE IN THE EXPERIMENTAL ATOMIC POWER PLANT KAHL. A. A. Weckesser and H. J. Bruechner. Atomkernenergie, 8: 383-9(Nov. 1963). (In German)

Kahl began operating at load in June 1961. Kahl is equipped with a boiling water reactor, operating in an indirect cycle and with natural circulation. Its electrical net capacity is 16 Mw, and the power produced until mid April 1963 amounts to more than 160 million kwh. The operating experience, particularly the extensive testing program, is reviewed. Results about the operating performance of certain plant components such as control rod drive system, off-gas system, and turbine are presented. After this testing program the plant was operated at base load for some time in order to obtain realistic experience on fuel performance. Thereafter the plant was shut down in order to install a nuclear superheating test loop in the reactor. (auth)

6497 THE AQUEOUS, HOMOGENEOUS, SUSPENSION REACTOR OF THE KEMA. M. E. A. Hermans, J. A. H. Kersten, and J. J. Went (Kernreaktorlaboratorium der KEMA, Arnhen, Ger.). Atomwirtschaft, 8: 593-9(Nov. 1963). (In German)

The concept of the KEMA is based on the opinion that, in the long run, only the development of a so-called breeder reactor represents an effective solution of the energy shortage which the future threatens. The breeder reactor offers the possibility of converting U^{238} or Th^{232}, which are thermally not fissionable, into Pu^{239} or U^{233}, respectively and so the utilization of practically unlimited supplies of low grade ores. A thermal breeder reactor which uses the Th^{232}/U^{233} cycle has a maximum conversion factor when neutron absorbing material in the reactor is avoided by the use of heavy water as moderator and a homogeneous construction. A further increase in the conversion factor can be obtained if the reactor is so constructed that the fission products can be removed either wholly or in part during reactor operation. In a homogeneous water reactor the fissionable material may be used in the form either of dissolved salts or of oxide particles. In both cases the fissionable element is easy to make and the reprocessing is simpler and cheaper. Capital investment in heavy water is relatively smaller for the reactor dealt with here than for a comparable heterogeneous type. The aim of the development work is to establish whether aqueous suspensions can be used as the fissionable material for homogeneous reactors and where the limits lie. The extent to which aqueous suspensions form serviceable fissionable materials will only be known after the completion of these experiments, called

the KEMA suspension test reactor (KSTR). Before constructing the KSTR a sub-critical assembly was built to obtain the first results on the kinetic, physical, and chemical behavior of the reactor. The KSTR is to be a critical assembly in which a suspension of about 4% by volume of a UO_2–ThO_2 mixed oxide in light water is circulated in a system consisting of a reactor vessel, a heat exchanger, and a pump. The fissionable material and erosion problems are the subject of extensive research. (auth)

6498 NUCLEAR POWER PLANTS—ECONOMIES IN DESIGN AND CONSTRUCTION. Civil Eng. (N. Y.), 33: 4p. (May 1963).

Economies in design and construction of containment vessels and shielding structures for power reactors are discussed. Construction cleanliness is also discussed. (R.E.U.)

6499 NEW CONTAINMENT PRINCIPLE FOR NUCLEAR POWER STATIONS. Energy Intern., 21-3(Oct. 1963).

A pressure suppression principle is described that eliminates need for dry-type capsule enclosure of reactor vessels. A water pool surrounds the reactor dry well so that if a break were to occur in the primary steam system, the released steam-water mixture would be vented into the water pool and condensed. The principle is described in its use at the Humboldt Bay Power Station. (R.E.U.)

6500 FUTURE OF NUCLEAR POWER PLANTS IN COUNTRIES IN THE PROCESS OF DEVELOPMENT. Pierre Sevette. Ind. At., 7: Nos. 9-10, 107-16(1963). (In French)

The factors that condition the degree of economy of the integration of nuclear energy in the energy system of developing countries are examined. A number of factors, that are analyzed in detail, lead to a considerable increase in the cost of electrical energy produced by the low-power reactors which are best suited at the present and for a long time to come to the needs of these countries. (tr-auth)

6501 KINETIC BEHAVIOR OF STEAM VOID IN BOILING WATER REACTOR. Masahiko Utsuro and Yoshifumi Sakurai (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 5: 908-16(Nov. 1963).

A zero power reactor simulator and thermodynamic-hydrodynamic coolant loops were used to investigate BWR dynamics. The instability that appeared in thermodynamic and hydrodynamic loops in natural circulation condition is the most noticeable phenomenon. To investigate the instability, the boiling loops were operated only as the first step. Combining the zero power reactor simulator and thermodynamic-hydrodynamic loops in a closed form by use of an electric capacitor type of void fraction detecting device, satisfactory results in BWR simulation were obtained. The effects of void coefficient of reactivity on the whole BWR dynamics were investigated, along with the influence of the coolant circulation condition. It was concluded that the properties of power-void feedback transfer function have the predominant effects on the overall reactor dynamics. The power-void transfer function was investigated further and compared with the theoretical transfer function. (P.C.H.)

6502 BURST CARTRIDGE DETECTION IN BRITISH GAS-COOLED REACTORS. K. H. Dent (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.) and D. W. Williams. Proc. Inst. Mech. Engrs. (London), 177: 309-46(1963).

A fission product precipitation system is described for the detection of burst cartridge. Gaseous fission products diffuse through the leak in the can wall against a coolant inflow induced by oxidation of the fuel, and their presence in the coolant has to be detected against an unavoidable background count. The leak size at the threshold of detection can be estimated from the operating conditions, and the manner in which b.c.d. (burst cartridge detection) signals arise from a developing burst merits special study. To discriminate against the radioactive decay of the coolant gas itself the precipitation system of monitoring is used. From each fuel channel in the reactor a sample of gas is drawn periodically. This is passed through a precipitation chamber where particular fission product nuclides decay to give ionized daughter products which are collected on a charged wire. The wire is moved to a shielded scintillation counter and the fission product nuclides, which undergo a second radioactive transition, are measured to the exclusion of the active nuclides in the coolant which do not. The performance and sensitivity of the system can be calculated and optimized by considering the expression for the count from the wire. The mechanical design of the equipment varies in detail from station to station. In later designs the mechanical equipment is simpler and easier to maintain, and greater use is being made of automatic processing and presentation of the signal. (P.C.H.)

6503 REACTOR PHYSICS EXPERIENCE OBTAINED FROM THE EXPERIMENTAL OPERATION OF THE HALDEN HEAVY-WATER BOILING REACTOR. H. Ager-Hanssen and J. E. Lunde (Halden Reactor Project, Norway). p.211-49 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

Buckling and temperature coefficient measurements on the 7-rod cluster elements of 1.5% enriched UO_2 clad in Zircaloy for moderator temperatures of 60 to 225°C are presented. From comparison with the results predicted by a four-factor, two-group recipe it can be concluded that, in the calculation of the temperature dependence of the temperature coefficient, the recipe does not give an adequate accuracy. (auth)

6504 COMPACT MOBILE NUCLEAR POWER PLANT. Joseph Ronald Wetch, Herman Maier Dieckamp, and Monte Vincent Davis (to North American Aviation, Inc.). British Patent 938,446. Oct. 2, 1963. Filed Nov. 14, 1961.

A compact boiling-water nuclear-reactor power-producing system operating in the epithermal neutron-energy range is capable of mobility and long-life operation. Mounted on a trailer are an electrical equipment cubical, a steam condenser, and a containment vessel. The nuclear reactor within the containment vessel has a core composed of six prism-shaped sections containing clusters of triangularly pitched fuel rods. The preferred fuel composition is a zirconium hydride–uranium alloy. The hydrogen content of the zirconium hydride is varied across the core radius in such a manner as to flatten the radial power distribution in the core. Reactor control and shutdown is accomplished by eight rotating reflector drums arranged for gang operation. The drums are constructed of nickel and hafnium hydride. Means are provided for pumping water into the reactor core, extracting steam from the core, and converting the steam to electricity. The unit is capable of providing 2 Mw(e) for a minimum full power core life of 5000 hr. (A.G.W.)

6505 BOILER-SUPERHEATER REACTOR. Thomas P. Heckman (to U. S. Atomic Energy Commission). U. S. Patent 2,982,712. May 2, 1961. Filed Aug. 8, 1958.

A nuclear power reactor of the type in which a liquid

moderator-coolant is transformed by nuclear heating into a vapor that may be used to drive a turbo-generator is described. The core of this reactor comprises a plurality of freely suspended tubular fuel elements, called fuel element trains, within which nonboiling pressurized liquid moderator-coolant is preheated and sprayed through orifices in the walls of the trains against the outer walls thereof to be converted into vapor. Passage of the vapor over other unwetted portions of the outside of the fuel elements causes the steam to be superheated. The moderator-coolant within the fuel elements remains in the liquid state, and that between the fuel elements remains substantially in the vapor state. A unique liquid neutron-absorber control system is used. Advantages expected from the reactor design include reduced fuel element failure, increased stability of operation, direct response to power demand, and circulation of a minimum amount of liquid moderator-coolant. (A.G.W.)

6506 NUCLEAR REACTOR. Bernard A. Mong (to The Babcock and Wilcox Co.). U. S. Patent 3,103,477. Sept. 10, 1963. Filed Dec. 2, 1958.

A new fuel element assembly is provided in the internal converter reactor described. Each fuel pin is an open-ended cylindrical stainless steel tube. Arranged in it is a column of cylindrical fuel pellets stacked end to end. The fuel pins are arranged in uniform circumferential rows with the rows uniformly spaced to form a cylindrical core. Control rods of a double biconcave shape are provided to substantially fill the spaces between the fuel assemblies. The control rods are hollow for passage of coolant. The core of this reactor is intended to contain fertile material to be converted to fissionable material in the reactor neutron flux. The reactor can also be used for generation of steam for production of electricity. (A.G.W.)

6507 PRESSURE TUBE STRUCTURE. Thomas O. P. Speidel and Robert C. Howard (to General Dynamics Corp.). U. S. Patent 3,104,218. Sept. 17, 1963. Filed Oct. 1, 1958.

A pressure tube structure suitable for use in a gas-cooled nuclear power reactor comprises an outer pipe adapted to accommodate a stream of coolant gas under pressure and flowing in the direction of the longitudinal axis of the pipe, a group of spaced round rods for containing nuclear fuel positioned within the outer pipe with their axes parallel with the axis of the outer pipe, and a grid for maintaining spacing of the rods while permitting flow of gas coolant through the pipe. The grid is made of thin strip metal in the form of a modified honeycomb. It consists of parallel rows of six-sided cells. Each cell has two opposed sides substantially shorter than the other four sides, which abut and are united to the shorter sides of the adjacent cells. The rods are positioned in alternate rows of these cells. (A.G.W.)

Production Reactors

6508 (HW-77356) INVESTIGATION OF CHEMICAL CLEANING AND START-UP OPERATIONS PROPOSED FOR N-REACTOR. A. P. Larrick, T. F. Demmitt, and V. F. FitzPatrick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1963. Contract AT(45-1)-1350. 27p.

The startup phases of the Hanford N-Reactor with its predominately carbon steel coolant systems, present numerous precleaning, corrosion, and water quality problems. Tests designed to provide information on cleaning a newly constructed carbon steel system, water quality during operation following the cleaning, and corrosion penetrations during both periods, were conducted in the K-1 in-reactor, carbon steel test loop. The effects of lay-up on subsequent water quality were also investigated. (auth)

6509 (LADC-5569) CRYOGENIC FLUIDS IN NUCLEAR PROPULSION SYSTEMS. R. S. Thurston, J. D. Balcomb, G. P. Watts, R. S. Pollock, and A. R. Lyle (Los Alamos Scientific Lab., N. Mex.). Jan. 1963. Contract [W-7405-eng-36]. 39p.

Nuclear rocket engines employ hydrogen, a cryogenic liquid, as a propellant in order to obtain a system with a high specific impulse. Since hydrogen is also an excellent moderator of neutrons, it provides a reactivity contribution which must be taken into consideration in the design of a reactor and in its programmed operation. The reactivity worth of hydrogen is a function of its density distribution. The prediction of this quantity was facilitated by heat transfer experiments, which were simulated on a digital computer. Pressure oscillations associated with the two-phase flow of hydrogen were simulated by means of a spring-mass model. (auth)

Propulsion and Space

6510 (63SD886) RESEARCH ON SPACECRAFT AND POWERPLANT INTEGRATION PROBLEMS. Second Quarterly Report, July 26 to October 26, 1963. John W. Larson (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Contract NAS 3-2533. 265p.

Major emphasis is on the design of the 1-Mw(e) Rankine cycle powered spacecraft. The heliocentric phases of planetary missions are analyzed and results obtained for Jupiter, Saturn, Uranus, Neptune, and Pluto. Effort is continuing on Mercury heliocentric, out-of-ecliptic, and solar probe trajectories. An interesting result of the heliocentric studies is the reduction of data to a characteristic distance relating mission time, specific impulse, and spacecraft mass ratio. A LEADER program is prepared for use in optimizing spacecraft parameters for selected NAVIGATOR missions. The design study of spacecraft configuration centered about the choice between a deployable and a non-deployable radiator for the 1-Mw(e) turbo-electric system. The launch requirements are satisfied by the conical radiator configuration. The radiator weight, primary plus auxiliary cooling, is estimated at 9,800 pounds, which is 9.8 lb/kw(e) and 3.4 lb/ft^2 of radiating surface, including headers, feeders, structure, and other support items. Preliminary shielding studies indicate that the shield is not a major spacecraft item. Scattering from the radiator to the payload is significant and scatter shielding must be provided. The shield can probably be passively cooled. The electrical system is quite complex because of the many services performed. A first pass circuit diagram is studied. The guidance and control portion of the electrical system consists of using some of the electric thrusters for attitude control. The power generation system is estimated at about 8,000 pounds for a 1-Mw(e) system, exclusive of reactor, shield, and radiators. Thus, the complete powerplant specific weight is around 28 lb/kw input to the electric thrusters or other payload items. The study is centered on the 2600-lb turbogenerator assembly. Electric power and dimensional requirements of various electric thrusters are estimated. The principal state-of-the-art limitation is electrode erosion, which limits efficiency, size, and weight. Payload weight data are amplified. (auth)

6511 (AED-C-22-01) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. SCHIFFSANTRIEB DURCH KERNENERGIE. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Marine Propulsion by Nuclear Energy. Bibliographic Compilation). J. N. Paro, comp. (Reactor Centrum Nederland, The Hague). Oct. 1963. 40p.

One hundred and twenty-seven references on marine propulsion by nuclear energy are presented. Report number, author, and subject indexes are included. (M.C.G.)

6512 (BAW-170) RESULTS FROM EXAMINATION OF HIGH BURNUP SPECIMENS FROM NS SAVANNAH, CORE I IRRADIATION PROGRAM. W. R. DeBoskey (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). [Nov. 1961]. 11p.

Post-irradiation examination revealed an apparent irradiation-induced abnormality between two similar fuel rod specimens that had been irradiated side by side in the Engineering Test Reactor (ETR). One rod had a central void with associated columnar grain structure which was attributed to sublimation-condensation. The pellet structure of the other rod apparently remained in the "as-fabricated" condition. Fission gas release was 5.6% and 8.9% respectively for the two rods. The explanation is associated with the time-sequence variation of instantaneous fuel rod operating conditions and the resultant fission gas release mechanisms. Fuel redistribution early in the exposure period results in low percentage gas release, while redistribution late in exposure yields high releases. (auth)

6513 (CONF-311-8) AEC AEROSPACE SAFETY PROGRAMS AND PHILOSOPHY. Frank K. Pittman (Division of Reactor Development, AEC). Oct. 1, 1963. 12p.

From American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

Work in aerospace safety analysis, research, development, and testing is discussed. Studies for the SNAP program are outlined. The engineering and test program for aerospace safety is described. (M.C.G.)

6514 (NAA-SR-Memo-8824) REPORT OF THE QUALIFICATION TESTING OF SNAP 10A FUSISTORS. J. S. Holtwick, III and V. P. Nowell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 31, 1963. Contract [AT(11-1)-Gen-8]. 31p.

Qualification testing of SNAP 10A fusistors was performed. Test operations included: visual inspection, insulation resistance, dielectric strength, and d-c resistance testing prior to subjecting the fusistors to environmental testing; opening-time testing prior to, during, and following vacuum and temperature testing; and insulation resistance, dielectric strength, and d-c resistance testing following environmental applications of temperature, vacuum, and sinusoidal vibration. (auth)

6515 (NAA-SR-Memo-9101) STREP (SNAP TEMPERATURE REDUCTION PLOTTING). Katharine W. Medeiros (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 1963. Contract [AT(11-1)-Gen-8]. 67p.

STREP is a general-purpose program for linear plotting of parameters, in optional groupings, against a common abscissa. (auth)

6516 (SY-5396-R6) SPUR POWER SYSTEM. Quarterly Progress Report for Period Ending September 30, 1963. (Garrett Corp. AiResearch Mfg. Div. of Arizona, Phoenix). Oct. 15, 1963. Contract AF33(657)-8954. 39p.

Progress is reported on creep-rupture and fatigue properties of molybdenum–titanium alloy, cantilever bending fatigue of niobium–zirconium alloy, mass transfer tests with two-phase flow, bearing tests, and physical and metallurgical properties of clad and structural materials. (N.W.R.)

6517 ASSEMBLY OF SOLID MODERATOR ELEMENTS FOR HIGH TEMPERATURE NUCLEAR REACTORS SUBJECTED TO ACCELERATIONS. Gilbert Mission and Henri Meulien (to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). U. S. Patent 3,102,089. Aug. 27, 1963. Priority date Dec. 4, 1959, France.

The assembly of solid moderator elements described is suitable for use on movable vehicles capable of subjecting it to substantial inclinations to the vertical and to considerable accelerations or decelerations. Each of the parallel moderator columns consists of a stack of blocks and includes an axial channel for receiving fuel elements and for permitting circulation of a refrigerant fluid. The columns are mutually independent and are capable of expanding laterally by reason of clearances provided between adjacent columns and axially by means of resilient guide means, which also provide axial compression for giving mechanical cohesion of each column. The resilient guide means comprise terminal members disposed at one end of each of the columns and carried by support members connected to the reactor casing and tubular terminal members disposed at the other end of each of the columns and surrounding fixed sleeves relative to which the tubular members are longitudinally movable, helical springs being seated between shoulders provided on each tubular member and its associated sleeve. (A.G.W.)

Research and Test Reactors

6518 (CONF-243-36) DESIGN REVIEW AND SAFETY ANALYSIS OF EXPERIMENTS IN ORNL RESEARCH REACTORS. L. E. Stanford and R. A. Costner, Jr. (Oak Ridge National Lab., Tenn.). [June 1963]. Contract W-7405-eng-26. 48p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A discussion is presented of the philosophy and experiences of the design review and safety analysis of complex irradiation experiments in ORNL research reactors. The principles and rules of design are outlined and the limitations of their application are discussed. The minor incidents encountered in 1960 to date are described, and the steps taken to prevent their recurrence are discussed. It is concluded that the described safety procedures have resulted in a safe reactor and experiment complex. (D.L.C.)

6519 (EUR-490.e) A STUDY ON THE PERFORMANCE OF NEUTRON BEAM EXPERIMENTS AT THE PULSED FAST REACTOR SORA. R. Haas and H. B. Moeller (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 63p.

The characteristics of double choppers, rotating crystal spectrometers, and fast choppers for neutron research with the SORA reactor at specified operating characteristics are established. The intensities and resolutions for the instruments are estimated and compared with those for similar instruments operating at linear accelerators and very high flux reactors. Reactor operation, shielding, and beam hole requirements are given, and the thermal neutron flux vs time in a small moderator is estimated. (D.C.W.)

6520 (HMI-B-29) VERHALTEN VON GASFÖRMIGEN SPALTPRODUKTEN IM BER. (Behavior of Gaseous Fission Products in the BER Reactor). E. Ehn (Hahn-Meitner-Institut für Kernforschung, Berlin). Nov. 1963. 29p.

The behavior of radioactive gases in flowing through a tank, a tube, and the gas circuit of the BER reactor is treated theoretically. Approximate equations are given for the behavior of radioactive gases in the fuel solution of the reactor. The equations were used to evaluate data from decontamination solutions from the reactor. A mean residence time of about 11 sec was calculated for rare-gas fission products in the fuel solution before diffusing into a gas bubble. A mean residence time of about 1.5 sec was indicated for the gas bubbles in the solution. Other measurements showed that less than 1% of iodine fission products leave the fuel solution. (auth)

6521 (IDO-16906) SPERT I LOW-ENRICHMENT OXIDE CORE DESTRUCTIVE TEST PROGRAM SAFETY ANALYSIS REPORT. J. E. Grund and B. E. Norton (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 30, 1963. Contract AT(10-1)-205. 123p.

The objectives of an oxide core destructive test program at the Spert I reactor facility are reviewed. The proposed experimental program of destructive tests on a low-enriched oxide core, the experimental results of nondestructive transient tests that were obtained on the test core and the extrapolation of these results to the destructive case, an analysis of the hazards involved in performing such destructive tests, and a detailed description of the reactor facility and environmental conditions are presented. The supervision and control of personnel during and after each destructive test, and of the plans for reentry, cleanup, and restoration of the facility are discussed. The water-moderated core that will be used for these experiments is mounted in the Spert I open-type reactor vessel, which has no provision for pressurization or forced coolant flow. The core is comprised of approximately 600 4%-enriched UO_2 fuel rods clad with stainless steel, and four blade-type, gang-operated control rods for reactor control. Reactor transients are initiated at ambient temperature by step-insertions of reactivity, using for this purpose a special control rod that can be quickly ejected from the core. On the basis of the results obtained from previous nondestructive kinetic tests, an analysis was made to determine the nature of the results to be expected for an assumed 1.8-msec-period test in which total core destruction occurs. An evaluation of hazards involved in conducting the 1.8-msec test, based on conservative assumptions regarding fission product release and weather conditions, indicated that with the procedural controls normally exercised in the conduct of any transient test at Spert and the special controls to be in effect during the destructive test series, no significant hazard to personnel or to the general public will be incurred. (auth)

6522 (NP-13438) SYSTEMA AVTOMATIZATSII ISSLEDOVATEL'SKIKH REAKTOROV. (Automation System for Research Reactors). I. Iftode, K. Tsapu, and K. Kobrisku (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). Apr. 1963. 10p.

The control system of research reactors must be able to safeguard their operation under widely varied conditions, such as startup from zero power, functioning at steady state power, transition from one power level to another, etc. The startup is the most difficult operation and requires a very sensitive instrumentation because it involves the estimation of the critical mass by the operator; this is complicated by factors such as Xe poisoning, variation in the initial temperature of the cooling agent, and insertion of foreign materials in the core for experiments or for isotope production. These points can be taken care of only by completely automating the operations. The control system was improved by incorporating a high-resolution amplifier in it. The automatic system consists of a measuring and an error-signal unit, a logarithmic operation relay, safety and control rod mechanisms, and a special control system for the movable ionization chambers and the shim rods. The system was checked by means of an analog computer, then was installed in the VVR-S reactor. It is planned to replace the usual relays by static ones, probably also using magnetic amplifiers. (TTT)

6523 (ORNL-3499(Vol.I)(p.81-5)) REACTIVITY EFFECTS OF VARIOUS REFLECTORS NEAR THE HEALTH PHYSICS RESEARCH REACTOR. L. W. Gilley (Oak Ridge National Lab., Tenn.).

The reactivity effects of several Plexiglas reflectors on the HPRR were measured in order to obtain a basis for predicting the effects of proposed experiments with the reactor. The effects of using the reactor safety cage and crash plate were also evaluated, as well as the effects of the reactor building floor and a reactor storage pit. (auth)

6524 (ORNL-3499(Vol.I)(p.85-9)) REACTIVITY CHANGES ASSOCIATED WITH RAPID LOCALIZED TEMPERATURE CHANGES IN THE HEALTH PHYSICS RESEARCH REACTOR CORE. D. R. Ward (Oak Ridge National Lab., Tenn.).

Experiments were performed to determine whether reactivity changes resulting from a temperature change in a portion of the core could occur before any of the five core thermocouples indicate the temperature change. It is concluded that the thermocouples adequately indicate core temperature changes. (auth)

6525 (ORNL-3499(Vol.I)(p.98-105)) MEASUREMENTS OF FAST-NEUTRON SPECTRA WITHIN AND AT VARIOUS DISTANCES FROM THE BULK SHIELDING REACTOR I. M. S. Bokhari, V. V. Verbinski, and J. D. Kington (Oak Ridge National Lab., Tenn.).

Measurements were made within the core at the core-shield interface, and at various positions within the water shield with the shielded-diode spectrometer. The data obtained along the normal to the reactor face show a hardening of the spectrum with increased distance in water and the presence of dips in the spectrum corresponding to resonances in the oxygen total cross section at 1.3, 3.7, and 4.1 to 4.3 Mev. These dips essentially disappear and the spectrum becomes softer at 51 and 40.5° from the normal. (auth)

6526 (ORNL-3499(Vol.I)(p.105-8)) MEASUREMENT OF THE FAST-NEUTRON BEAM SPECTRUM FROM THE TOWER SHIELDING REACTOR II. M. S. Bokhari, V. V. Verbinski, and H. A. Todd (Oak Ridge National Lab., Tenn.).

The spectrum was measured with the shielded-diode spectrometer. The results, given in absolute neutron flux, compare favorably with the results of a direct measurement using nuclear emulsions and with an indirect measurement using a dosimeter. (auth)

6527 (RISÖ-32) A DECAY TANK FOR NITROGEN 16 AT THE DANISH REACTOR DR 2. Arne Pedersen, Karl Ove Nielsen, and Rolf Andersen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Sept. 1961. 19p.

During the initial power operation of the Danish 5-Mw research reactor DR 2 it was found that the decay tank in-

stalled in the primary cooling system between the reactor tank and the equipment area insufficiently reduced the N^{16} activity in the light-water coolant. Different methods for redesigning the decay tank are discussed. In the design finally chosen the kinetic energy of the inlet water stream is used to generate a swirl in which the water particles proceed through the tank. Results of investigations made before and after the tank was rebuilt show that the N^{16} concentration in the cooling water was reduced during the passage through the tank by factors of 69×10^{-4} and 0.6×10^{-4}, respectively (for the tank volume in the system the theoretical limit of the above-mentioned reduction factor is 0.15×10^{-4}). This improvement was obtained without any increase in the pressure loss or other disadvantages necessitating changes elsewhere in the system. (auth)

6528 (AEC-tr-6144) DIFFUSION OF ACTIVE IODINE THROUGH WATER, WITH THE IODINE BEING LIBERATED IN CO_2 BUBBLES AT HIGH TEMPERATURE. A. Barthoux, J. Coulaud, and R. Haulet (France, Commissariat a l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). Translated from report PAS-62/17. June 1962. 18p.

Studies were made to determine rapidly the coefficient of transmission of iodine through water under the conditions of accidental CO_2 leaks in the loop of the Pegase. Results are presented in graph form. (M.C.G.)

6529 FLOW FAILURE TESTS ON BR-2. K. J. Bobin, F. Mathieu, and R. Wanhaelewijn (CEN Euratom, Mol, Belg.). Nucl. Eng., 8: 434-6(Dec. 1963).

Flow failure tests carried out on the Belgian high-flux materials testing reactor BR-2 showed not only that every possible coolant failure at the full design power will lead to acceptable conditions, but that it would be safe to operate at 50% above the design power. Heat fluxes of 600 W/cm^2 were successfully attained and operation at higher levels is shown to be feasible. (auth)

6530 KSTR THE KEMA SUSPENSION TEST REACTOR. Nucl. Eng., 8: 437-9(Dec. 1963).

A zero-energy assembly for studying the KEMA Suspension Test Reactor (KSTR) is in operation. A prototype 250-kw reactor is being constructed. Control, chemical, mechanical and maintenance problems are discussed. The reactor vessel, reflector, neutron source, control, instrumentation, and flux monitoring and safety circuits for the zero-energy assembly are described. (M.C.G.)

6531 EXPERIENCE CRITIQUE ORGEL. MODEL FOR REACTOR PHYSICS STUDIES. Nucl. Eng., 8: 440-1(Dec. 1963).

The Orgel critical experiment, ECO, is described. The structure, pitch mechanism, physics details, burnup simulation, and initial operation are discussed. (M.C.G.)

6532 GENERAL REPORT ON THE AQUILON EXPERIMENTS. Y. Girard and R. Naudet (CEN, Saclay, France). p.93-121 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963. (In French)

All experimental work on the AQUILON critical facility since it went into operation in 1956 and especially since the last Geneva Conference is summarized. A short description of the facility as it now is (AQUILON II), a summary of the various series of measurements made, and a wide selection of the more significant results from up-to-date Laplacian measurements are included. A list of the fuels is given. (auth)

6533 DESCRIPTION OF SOME RECENT EXPERIMENTS USING AQUILON. Y. Girard and R. Naudet (CEN, Saclay, France). p.123-45 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963. (In French)

Three groups of experiments on comparisons of natural uranium lattice types are described. They are of recent date and some are still in progress. Only purely provisional results can therefore be given, and it is chiefly the principle that is discussed. The first program, which will continue throughout 1963 and beyond, consists of comparing fuel composition changes in lattices of the same geometry: i.e., slight variations of the isotopic content of the uranium, addition of very small amounts of plutonium, and fuel reconstituted with highly depleted uranium and with plutonium. These experiments are associated with measurements by oscillation. The second program comprises measurements of neutron leakage due to moderator poisoning. These were specially designed for uranium oxide cluster and gas tube lattices where the problem of leakage is particularly difficult. A description of certain fine measurements in uranium oxide clusters enclosed in tubes of gas is presented. These either have a utilitarian purpose (for the EL 4 project) and involve hyperfine distribution of heat sources, flux recordings at fuel element extremities, etc., or else are of physical interest (measurements of spectral indices). (auth)

6534 THE STUDY OF THE FIRST ZERLINA CORE. V. C. Deniz (Atomic Energy Establishment, Trombay, India). p.201-10 of "Heavy Water Lattices: Second Panel Report." Vienna, International Atomic Energy Agency, 1963.

It is proposed to use this as a reference lattice for a series of experiments, employing the replacement technique, in connection with the organic-cooled reactor project. Particular attention is given to the effects of the reflectors, a comparison being made between the experimental values and the theoretical values calculated with a simple model assuming the separability of variables. It is shown that this simple model is not adequate for a good evaluation of the reflector effects. The flux plot in the core indicates quite clearly the variation of reflector savings with radius and with height, showing that the assumption of separability of variables is invalid for a reactor system like ZERLINA. (auth)

6535 IMPROVED NUCLEAR REACTOR SYSTEM. (to General Dynamics Corp.). British Patent 938,159. Oct. 2, 1963. Priority date Jan. 30, 1961, United States.

A reactor system is provided wherein the reactor core may be moved to separate positions within a reactor tank to permit its use in separate exposure areas and for irradiation of specimens in the tank. The reactor core is cylindrical, and the tank is provided with two semi-cylindrical projections to receive the core at opposite ends of the tank. An irradiation facility in the form of a generally rectangular room is disposed adjacent each projection. Suitable shielding is provided about the outer face of the projection in each room. A movable radiation shield is provided in the tank between the two irradiation facilities in order to permit safe access to one of the rooms while the other room is irradiated. The core is moved between the projections by carriage means supported on rails above the tank. The tank is filled with a suitable liquid, such as water, which serves as reflector, moderator, coolant, and radiation shield. The arrangement permits selective irradiation with either thermal or unmoderated neutrons and permits irradiation of relatively large objects. (A.G.W.)

WASTE DISPOSAL AND PROCESSING

6536 (HW-79393) FEASIBILITY OF REMOTELY SEAL WELDING FISSION PRODUCT WASTE CONTAINERS. L. J. Rousseau (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1963. Contract AT(45-1)-1350. 21p.

A study was conducted to determine the feasibility of remotely seal welding stainless steel caps to filler necks for fission-product waste containers. Complete remote application of the welding process, high temperatures in the weld area, gas pressure inside the container, weld joint contamination, and reproducibility of the welds were considered. It was concluded that repetitive welds can be readily made under the conditions considered. (M.C.G.)

6537 (ORNL-TM-603) WASTE TREATMENT AND DISPOSAL QUARTERLY PROGRESS REPORT, FEBRUARY–APRIL 1963. R. E. Blanco and F. L. Parker (Oak Ridge National Lab., Tenn.). Dec. 16, 1963. Contract W-7405-eng-26. 121p.

Progress made in the development of integrated processes for the treatment and disposal of radioactive wastes resulting from reactor operations and reactor fuel processing is reported. Information is given on high-level waste pot calcination; fixation of high-level waste in phosphate glass; treatment of low-level waste by scavenging, ion exchange, and foam separation; waste disposal in deep wells and natural salt formations; mineral exchange studies; and Clinch River and White Oak Creek Basin studies. (N.W.R.)

6538 CALCINING TECHNIQUES TO EASE NUCLEAR-WASTE WOES. Chem. Eng., 70: No. 7, 26-8(Apr. 1963).

Four calcination processes under study are described: (1) A rotating kiln that operates at 1500°F. Through the use of aluminum nitrate as a simulated waste, the kiln evaporates water and decomposes the aluminum nitrate to aluminum oxide, which goes into storage. The gases are separated, partially condensed, and scrubbed before they are vented. (2) A fluid-bed calciner that consists of a fluidized bed of previously-calcined material to which fresh feed is supplied. The calcined product is continuously removed. The off-gases are processed by separators, adsorption towers, then scrubbers. (3) Spray tower calcination in which waste slurry is atomized at top of heated tower to evaporate the solution, the particles drying and becoming calcined as they fall. The gases are similarly treated to the rotating kiln process. (4) Pot calcination, a batch procedure in which wastes are held for 20 to 30 hr, the pot serving as a permanent storage vessel. Gases are recycled to an evaporator. (TCO)

6539 THE DISPOSAL OF RADIOACTIVE EFFLUENTS. P. Bovard and M. E. Gahinet. Eau, L., 50: 301-6 (May 1963).

Various sources of radioactive contamination of water, including material sources, contributions from nuclear explosions, and industrial waste effluents are discussed. The problems associated with treatment of radioactive wastes are considered, particularly the problems encountered when field disposal involves possible contamination of rivers. (Public Health Eng. Abstr., 43: No. 11, 1963)

6540 THE WASTE PROCESSING PLANT OF THE HOT AND ISOTOPE LABORATORY. P. Graf, G. Maeder, and E. von Ruethi (EIR, Wurenlingen, Ger.). Neue Tech., 5: 520-6(Sept. 1963). (In German)

The liquid waste from the laboratory can be completely inactive, weakly radioactive, or highly radioactive. The weakly radioactive waste is processed by chemical precipitation and ion exchange. The processing installation and its monitoring system are described. (J.S.R.)

6541 THE REMOTE-CONTROLLED PURIFICATION PLANT FOR ACTIVE LIQUID WASTES. P. Graf (EIR, Wurenlingen, Ger.), W. Griner, E. von Ruethi, and H. Studer. Neue Tech., 5: 527-31(Sept. 1963). (In German)

The installation for the purification of the highly radioactive liquid wastes by filtration, ion exchange, and evaporation is described. The decontaminated water is led into the processing system for the weakly radioactive wastes. The monitoring system and the electropneumatic remote-control system of the installation are described in some detail. (J.S.R.)

6542 THE INSTALLATION FOR THE EVAPORATION OF RADIOACTIVE LIQUID WASTES. P. Baertschi and H. R. von Gunten (EIR, Wurenlingen, Ger.). Neue Tech., 5: 531-5(Sept. 1963). (In German)

The evaporating system consists of the evaporator itself and the steam-heating circuit. These are described. A series of inactive experiments was performed on the evaporator. The decontamination factors obtainable were calculated, and the results were in agreement with the laboratory-scale research. (J.S.R.)

6543 STUDIES ON TREATMENT OF RADIOACTIVE LIQUID WASTES BY FALLING FILM EVAPORATOR. Tokuro Mizushina, Takeichiro Takamatsu, Nobuo Mitsuishi, Tsutomu Fukumoto, and Takashi Yamada (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 5: 933-8(Nov. 1963). (In Japanese)

A falling film evaporator is proposed for treatment of radioactive waste solutions. A test apparatus was manufactured, and its decontamination capacity was studied using water and CMC aqueous solutions as Newtonian and non-Newtonian fluids, respectively, and LiCl as a tracer. When the liquid flow rates are 200 to 300 l/hr, and vapor mass velocities 100 to 1,000 kg/m^2hr, the decontamination factors are about 10^5 for the Newtonian fluid, which coincides well with the results previously obtained with a standard type evaporator, and about 10^4 for the non-Newtonian fluids. The mean retention time for the Newtonian fluid is about 0.26 sec, and that for the non-Newtonian fluid about 3.2 sec, when the liquid flow rate is about 200 l/hr. (P.C.H.)

6544 VOLUME REDUCTION OF RADIOACTIVE SLUDGES BY FREEZING AND THAWING TREATMENT. Tetsuo Mamuro, Toshio Ishiyama, and Takashi Matsumura (Osaka Radiation Center). Nippon Genshiryoku Gakkaishi, 5: 925-32(Nov. 1963). (In Japanese)

A small plant was constructed that adopts the freezing treatment for concentrating radioactive sludges. The volume reduction characteristic of the plant was investigated. The plant can handle 125 l of sludge per day and can reduce the final volume of the concentrated sludge to about 1/5000, 1/2000 and 1/4000 of the volume of the original waste water to be decontaminated, for bentonite-Konan Floc, calcium phosphate, and ferric hydroxide sludges, respectively, in the case that the separation by settling is applied as the treatment after thawing. Appreciably higher volume reduction ratio can be obtained when the vacuum filtration is applied after thawing. In the beaker-experiments that were

carried out, it was found that the addition of some polymer as agent is effective in improving the volume reduction or in shortening the settling time after thawing. This was applied for the large scale treatment by the plant and good results were obtained. (P.C.H.)

6545 MONITORING OF THE RADIOACTIVE CONTAMINATION OF WATER. II. MEASUREMENT METHODS AND THEIR APPLICATION. Sigfrid Mueller. Tech. Ueberwach., 4: 412-17(Nov. 1963). (In German)

In the last few years the measurement techniques for radioactivity monitoring of waste water have undergone significant changes. It is now possible to construct reliable instruments with which very low activities can be measured continuously and directly. A brief review is given of the methods and instruments used for the direct measurement of β, α, and γ activity. The measurements after enrichment of radioisotopes are indicated. (J.S.R.)

6546 IMPROVEMENTS IN METHODS OF SOLIDIFYING WATERY ATOMIC WASTE. Rudolf Alberti. British Patent 938,211. Oct. 2, 1963. Priority date Apr. 2, 1960, Germany.

In the method described radioactive waste water is introduced without stirring into a finely divided hydraulic binder contained in a mold, the mixture thus formed is allowed to set hydraulically, and the block is subjected to a finishing treatment for increasing its resistance against lixiviation and atmospheric and mechanical influences. The hydraulic binder may consist of a refractory cement either alone or together with suitable aggregates in a granular condition. The waste water may be introduced into the binder by tubes suspended in the mold. The tubes have a funnel-like upper end, apertures at fixed distances along their length, and are open at the lower end. The finishing treatment may consist of baking in an oven after the block has set or introducing an impregnating material through the tube used to insert the waste water. The impregnating materials may consist of water-repellent substances in a melted condition or in the form of solutions in a volatile organic solvent or emulsions, for example, liquid self-hardening synthetic resins such as casting resins or paraffin, lacquers, synthetic fat-amino or silicone compounds. (A.G.W.)

6547 DEVICE FOR THE REMOVAL OF DANGEROUS PRODUCTS. Jean Desroches and Francis Thubert (to Commissariat a l'Energie Atomique). British Patent 938,311. Oct. 2, 1963. Priority date Nov. 17, 1960, France.

The device described is intended for carrying away the radioactive waste products resulting from manipulations effected in sealed enclosures. A disposal can on a wheeled trolley can be positioned beneath a chamber communicating with the enclosure from which the products are to be removed. A detachable bag is fixed inside the disposal can, and an airtight hose connects the chamber and the disposal can. When the disposal can is filled with waste products, it is sealed with an airtight cover. Means are also provided for closing the chamber and the manipulation enclosure in such a manner that the filled vessel is removed without admission of air into the sealed enclosure. No external contamination is produced. The device contains no metallic parts in position to be attacked by corrosive fumes from the sealed enclosure. (A.G.W.)

6548 METHOD OF TREATING RADIOACTIVE WASTES. Thomas H. Milliken, Jr., Jack H. Krause, and Joseph J. Donovan (to Air Products and Chemicals, Inc.). U. S. Patent 3,101,998. Aug. 27, 1963. Filed Sept. 19, 1958.

A process is described for separation of radioactive cesium, strontium, and ruthenium from nitrate waste liquor solutions to a degree whereby such solutions may be discarded or further processed in normal patterns with simplified techniques. The waste solution is first treated to form the normally adsorbable bulk ions other than Cs, Sr, and Ru into a sol having no appreciable affinity for adsorption on ion exchange materials. Additives suitable for formation of the sol include oxides or hydrous oxides of Al, Ti, Fe, Th, or Zr, metal organic compounds of the same metals such as Al isopropylate, or oxycarbonates. The treated solution is then subjected to ion exchange with a siliceous acid-form ion exchange material, and the adsorbed Cs, Sr, and Ru are recovered. (A.G.W.)

GENERAL AND MISCELLANEOUS

6549 (CONF-349-1) SOME PHYSICAL PROCESSES CAUSING MOVEMENT OF IONS AND OTHER MATTER THROUGH SOIL. Don Kirkham (Iowa State Univ. of Science and Tech., Ames). [1963]. Contract AT(11-1)-1269. 42p.

From 15th Annual Phytopharmacy Symposium, Ghent, Belgium, May 1963.

A survey is presented of three processes of water movement which will result in movement of chemicals: miscible displacement, diffusion, and leaching. Miscible displacement is discussed in some detail. Movement of pesticides in soils is considered. (D.L.C.)

6550 (GTR-20) FUNDAMENTALS OF SINTERING. [PART] VII. Final Progress Report, July 1, 1961–June 30, 1963. J. Brett and L. Seigle (General Telephone and Electronics Labs. Inc., Bayside). Dec. 15, 1963. Contract AT(30-1)-2102. 55p.

The motion of fiduciary markers during the sintering of wire compacts of various materials was studied in order to obtain direct visual evidence of the presence or absence of plastic flow during sintering. In glass and cellulose acetate compacts, markers were carried into the voids with the transported material, indicating the predominance of plastic flow as a mechanism of densification. On the other hand, transport of material in nickel and copper compacts occurred without any noticeable movement of markers into voids, indicating the existence of another, presumably diffusional, mechanism of sintering in these materials. Sintering of the copper wire specimens was inhibited by the presence of oxide markers. Completing previous studies of the behavior of voids in porous copper prepared by the dezincification of brass, it was confirmed that the voids disappear rapidly when grain boundaries are restored to the specimens although they do not shrink in the absence of grain boundaries. Finally, studies of the nickel activated sintering of tungsten wire compacts revealed the growth of necks between wires at unusually low temperatures, but met with limited success due to embrittlement and premature fracture of the interwire bonds. (auth)

6551 (HNS-1229-38) SOME HYDROGEOLOGIC CHARACTERISTICS OF CRYSTALLINE ROCKS. Stanley N. Davis (Bradberry (Carroll E.) & Associates, Los Altos, Calif.). May 20, 1963. For Hazleton-Nuclear Science Corp., Palo Alto, Calif. Contract AT(29-2)-1229. 35p.

Water-bearing properties of crystalline rocks are dependent on the occurrence of joints and faults and the extent of weathering. Original porosity and permeability are so small in crystalline rock that, for most purposes, they can be ignored. Weathering commonly extends to depths of almost 100 feet. Joints tend to diminish in number with depth. Faults tend to close with depth. Thus, based on general geologic observations, permeability should decrease with depth. This conclusion is verified by a study of well-yield and water-injection data. Bulk permeabilities of most crystalline rock will be less than 0.03 darcy at depths greater than 1,000 feet. Most water in unweathered rock will flow through cracks which range in width from 0.001 to 0.1 centimeter. The wide variation in crack widths will give rise to large differences between calculated average ground-water velocities and actual maximum velocities. The maximum velocities may be from 4 to 100 times the calculated average velocities. (auth)

6552 (IS-734) DETERMINATION OF TURBULENT THERMAL DIFFUSIVITIES FOR FLOW OF LIQUIDS IN PIPES. William F. Beckwith and Ray Fahien (Ames Lab., Ames, Iowa). Nov. 1963. Contract W-7405-eng-82. 126p.

Eddy thermal diffusivities as a function of radial position and Reynolds number were determined for turbulent flow of water in a tube with a constant wall heat flux. The temperature and velocity profiles were measured, and the eddy thermal diffusivities were calculated by solving the energy balance equation using a semi-numerical technique. Also, the eddy momentum diffusivities were determined so that analogies between heat and momentum transport could be tested. The eddy thermal and momentum diffusivities as a function of radial position were found to reach a maximum value at a position about midway between the center and the wall of the tube. The eddy thermal diffusivities were correlated with Reynolds number and radial position. The turbulent Prandtl number was found to vary with radial position from a value less than unity at the center to a value greater than unity at the wall. These results agree with previous mass transfer work and with theoretical models. The space-averaged thermal and momentum diffusivities were found to be roughly linear in Reynolds number. Also, the space-averaged turbulent Prandtl number decreased with increasing Reynolds number approaching the value of unity. The ratio of the average flow velocity and space-averaged thermal diffusivity, expressed in terms of a Peclet number, was found to decrease slightly with Reynolds number. The momentum and thermal position Peclet numbers both varied similarly with position Reynolds number. Both position numbers increased near the wall, increasing faster than values given by correlations which have been previously proposed for eddy momentum diffusivities. A comparison of the thermal and momentum diffusivity results with mass diffusivity results indicates that molecular properties of the fluid have an important influence on the turbulent properties. (auth)

6553 (LAMS-2986) SWITCHING CIRCUIT ANALYSIS PROGRAM SCAP-1. Lewis F. Green (Los Alamos Scientific Lab., N. Mex.). Oct. 22, 1963. Contract W-7405-eng-36. 15p.

SCAP-1, a computer program designed for use on an IBM 401, Model A3, data processor to help verify the functional logic of electrical and hydraulic machine control circuitry, is described. The program determines the condition of circuit components and analyzes the function of multistage components. Use is limited to on-off circuits. (D.C.W.)

6554 (NP-13387) CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE. Rapport Sur L'Exercice, 1961. (Center for Study of Nuclear Energy. Report on Work, 1961). (Brussels. Centre d'Étude de l'Énergie Nucléaire). 94p.

The organization and objectives of CEN (Center for Studies of Nuclear Energy) in Belgium are discussed. The administration, public relations, finances, statistical data, reports and publications, and operational and developmental data are given. General aspects of the BR-1, -2, and -3 reactors and the Vulcain assembly are outlined. (T.F.H.)

6555 (NP-13390) L'ENERGIE NUCLEAIRE EN BELGIQUE. BILAN DES ACTIVITIES AU COURS DE LA PERIODE 1960–1962. (Nuclear Energy in Belgium. Sum-

mary of Activities for the Period 1960–1962). (France. Commissariat a l'Energie Atomique, Paris). 139p.

A review is given of: the organization of the Belgian nuclear-energy effort; applied and basic research in nuclear chemistry and physics; the nuclear industry; industrial, biological, medical, and agricultural applications of nuclear technology; financial aspects; international relations and liaison; relations with local authorities and agencies; licensing; information; and administration aspects of the Belgian Commissariat of Atomic Energy (CEA). (T.F.H.)

6556 (NYO-10690) EDUCATION FOR RADIATION SCIENCE AND ENGINEERING. V. Lawrence Parsegian (Rensselaer Polytechnic Inst., Troy, N. Y.). Aug. 3, 1963. Contract AT(30-1)-2940. 40p.

Some guides for educational programs for college teaching of radiation science and engineering are discussed. The study was initially proposed to determine how educational programs might support, and in turn make use of, the High Intensity Radiation Development Laboratory of BNL. (R.E.U.)

6557 (SC-DC-3440) THE REACTION OF LEAD AZIDE WITH CARBON DIOXIDE AND WATER VAPOR. M. A. Cook, R. T. Keyes, C. H. Pitt, and G. M. Thornley (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 15, 1963. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 38p.

Both crystalline and colloidal lead azide were treated in dry carbon dioxide gas, wet carbon dioxide gas, and in a mixture of water vapor and an inert carrier gas, at various water vapor pressures and temperatures near and above normal storage conditions. The formation of surface compounds was followed by electron micrographs taken at intervals during crystal treatment. The final surface products formed by this treatment were identified by infrared spectroscopy. It was determined that dry carbon dioxide had little effect on lead azide. However, water reacted readily with lead azide forming a basic lead azide, which in turn reacted with carbon dioxide to produce carbonates on the crystal surfaces. These carbonates were observed to form on lead azide under conditions approximating ambient storage conditions. Surface impurities thus formed may be expected to affect the initiation reliability of lead azide. Hence water does not appear to be an ideal storage environment for lead azide. (auth)

6558 (SC-DC-3565) THE DEVELOPMENT OF A TEMPERATURE PROBE AND TEMPERATURE SURVEY OF THE INTERACTION OF AN OBLIQUE SHOCK WAVE AND A TURBULENT BOUNDARY LAYER. Final Report ME-8. Victor J. Skoglund and Donald M. Yano (New Mexico. Univ., Albuquerque. Engineering Experiment Station). Oct. 1963. For Sandia Corp., Albuquerque, N. Mex. 123p. Contract AT(29-1)-789.

A miniature bare thermocouple probe was fabricated, calibrated, and used to measure temperatures in the interaction region of an oblique shock wave and a turbulent boundary layer. Boundary layer static and stagnation temperatures and velocities were calculated and isotherms and stagnation temperature contours were plotted for $2.64 < X/\delta < 3.00$ where X is the distance from the focal point of the shock wave and $\delta = 0.100$ inches is the boundary layer thickness upstream of the interaction. The wave geometry of previous investigations was verified. The stagnation temperatures of the boundary layer were affected upstream and downstream of the interaction. The bare thermocouple probe was deficient for boundary layer measurements because of variations in the recovery factor. (auth)

6559 (SC-TM-215-63(24)) SWITCHGEAR FOR A RECORDING MUELLER BRIDGE. D. W. Braudaway (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract [AT(29-1)-789]. 16p.

A switchgear that accepts multiple inputs with automatic or manual selection, thereby permitting cyclic observation of more than one resistance thermometer by the resistance recorder with automatic range extension, is described. (D.C.W.)

6560 (SGAE-1963/1B) REAKTORZENTRUM SEIBERSDORF. BEILAGE ZUM TÄTIGKEITSBERICHT, 1962. (Reactor Center Seibersdorf. Supplement to the Activity Report, 1962). (Österreichische Studiengesellschaft fur Atomenergie G.m.b.H., Vienna). 431p.

Research and development progress is reported on the ASTRA reactor, biology and agriculture, chemistry, electronics, metallurgy, physics, reactor development, isotope industrial applications, radiation protection, and equipment development. (M.C.G.)

6561 (TID-3720) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period, October–November 1963. (Division of Technical Information Extension, AEC). 18p.

A list is presented of 53 completed bibliographies and of 69 bibliographies in preparation during October and November 1963 of atomic energy literature. (auth)

6562 (TID-19804) RIGID ROTOR DYNAMICS. Ralph E. Kelley (Virginia. Univ., Charlottesville. Research Labs. for Engineering Sciences). Nov. 1963. Contract AT(40-1)-1779. 24p. (EP-3912-107-63U)

A theoretical analysis is presented of the dynamics of a cylindrical rotor. The rotor is considered to be a rigid body supported in flexible bearings, and exact equations of motion are derived. Computer programs are used to calculate transient solutions and steady-state solutions. The use of the solutions in designing the rotor for improved performance is considered. (D.L.C.)

6563 (TID-19831) STRAIN ELECTROMETRY AND PASSIVATION OF ALUMINUM. Technical Report No. XLVII. Bryant A. Miner, Terrell N. Andersen, and Henry Eyring (Utah. Univ., Salt Lake City. Inst. for the Study of Rate Processes). Oct. 31, 1963. Contract AT(11-1)-1144. 27p.

Aluminum wire electrodes were plastically strained by elongation in oxygenated aqueous sulfate solutions, and the resulting transients were studied as a function of experimental parameters. Upon elongation of the electrode, the potential increases immediately to V_{max}, then decays to V_h in ~0.01 sec, and finally decays to the steady-state potential V_{ss} in ~1 sec. The effects of the following parameters on V_{ss}, V_{max}, and V_h were studied: solution stirring, O_2 pressure, pH, Al^{3+} ion concentration, temperature, and percent elongation. A capacitor model of the phenomena is presented, and its calculated results are discussed in detail. (D.L.C.)

6564 (TID-19852) A SIMPLE SEPARATION OF LARGE QUANTITIES OF 8-HYDROXYQUINOLINE FROM TRACE GALLIUM. Alan Townshend and Louis Gordon (Case Inst. of Tech., Cleveland). [nd]. Contract AT(11-1)-582. 3p.

A simple method for the removal of large amounts of 8-hydroxyquinoline from aqueous solutions containing traces of gallium was devised. It involves steam volatilization of the organic compound, and more than 97% of the gallium is recovered as a non-volatile residue. (auth)

6565 (TID-19853) ELECTRICAL CONDUCTIVITY AND VISCOSITY IN FUSED SALT CELLS USING POROUS

DISCS. Technical Progress Report. Report 1938-1. Benson Ross Sundheim and Alexandre Berlin (New York Univ., New York). Dec. 15, 1963. Contract AT(30-1)-1938. 6p.

The conductances of $AgNO_3$ and $TlNO_3$ were measured in conventional semicapillary cells and in cells with porous Pyrex fritted disks at 213 to 318°C. The frequency dependences were found to be different for the two types of cells. Below 280°C, the $AgNO_3$ conductivity with the fritted disks is the same as that without disks, while that of $TlNO_3$ is 5 to 8% less. Above 280°C, the conductivity increases for both $AgNO_3$ and $TlNO_3$ with fritted disks, and the cations are passed into the glass; this is interpreted to be due to ion exchange of the salt with the glass under the influence of the electric field. The viscosities of $AgNO_3$ and $TlNO_3$ were also measured in Ostwald-type viscosimeters with and without Purex fritted disks; the results were identical. The effects of pressure and quartz fritted disks were also studied briefly. (D.L.C.)

6566 (WAPD-TM-370) SHLOG—A DATA RETRIEVAL PROGRAM FOR THE PHILCO-2000. H. Bohl, Jr., and B. P. Peterson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT-11-1-GEN-14. 56p.

SHLOG is a Philco-2000 program that will store on magnetic tape, and retrieve, two related systems of purely numeric data. The retrieved data can be printed, written onto answer filetapes, and/or tabulated. The tabulations are in the form of counts of the number of records of a certain class, summations of a particular parameter in each selected record, and normalized statistics that can be used to produce histograms. The format of each data system using the program is variable. The data systems best suited for the program are those that evolve from hundreds of tests performed on many similar experiments from which system tests, belonging to particular classes, are to be analyzed. (auth)

6567 (AI-Trans-11) THREE ARTICLES ON THE ELECTROSTATIC IMMERSION OBJECTIVE. Albert Septier. Translated by Anthony Cornell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.), from Compt. Rend., 235: 609-11; 652-5; 1621-2(1952). 10p.

A translation is presented of three papers on the electrostatic immersion objective. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 6568, 6569, and 6570.

6568 (AI-Trans-11(Paper 1)) RESOLVING POWER OF THE ELECTROSTATIC IMMERSION OBJECTIVE. Albert Septier. Translated from Compt. Rend., 235: 609-11(1952). 3p.

Theoretical estimates of the resolving power of a thermoelectric emission microscope were compared with experiment. (M.C.G.)

6569 (AI-Trans-11(Paper 2)) A NEW TYPE OF HIGH RESOLVING POWER ELECTROSTATIC IMMERSION OBJECTIVE. Albert Septier. Translated from Compt. Rend., 235: 652-4(1952). 3p.

In an attempt to obtain a very great extraction field, the following system was tested: a flat cathode placed in front of a conventional unipotential lens. But the presence of numerous aberrations necessitated complicating it somewhat. A resolving power of 100 mμ was obtained with the first tests. (auth)

6570 (AI-Trans-11(Paper 3)) EXPERIMENTAL STUDY OF THE FLAT-ELECTRODE ELECTROSTATIC IMMERSION OBJECTIVE: FOCUSING CURVES AND FOCAL DISTANCE. Albert Septier. Translated from Compt. Rend., 235: 1621-3(1952). 3p.

The focusing curve and focal distance of the effect of geometrical construction parameters on flat-electrode electrostatic immersion objective are discussed. (M.C.G.)

6571 (AI-Trans-12) INTERSTITIAL ATOMS IN FACE-CENTERED CUBIC CRYSTALS, PARTICULARLY IN COPPER. A. Seeger, E. Mann, and R. v. Jan. Translated by Anthony Cornell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.), from Phys. Chem. Solids, 23: 639-58(1962). 39p.

The geometry of all the possible equilibrium or non-equilibrium configurations of interstitial atoms in fcc crystals is discussed. It is shown that these occur within a polyhedron that occupies only a small fraction of the atomic volume. The interstitial in the stable equilibrium configuration, the so-called (100) dumb-bell, has two elementary modes of movement (migration and rotation). They are characterized by specifying the side of the polyhedron through which the interstitial atom has to move. The reorientation of the dumb-bells under external strains gives rise to a relaxation effect, which is discussed in some detail. This relaxation process was experimentally verified for cold-worked and irradiated nickel. The quantitative calculations of energies and displacements in seven symmetric equilibrium configurations was carried out for copper, employing an improved version of the model due to Seeger and Mann. The improvements allow, in particular, for the anisotropy of the elastic displacement field and for the large relative displacements of neighboring atoms. The influence of the choice of the Born-Mayer potential and of various cut-off and correction procedures are discussed and allowed for in some detail. The more important numerical results are: energy of migration of an interstitial atom in copper, 0.5 ev; energy of formation, 2.8 ev; and increase of the volume of a finite crystal due to one interstitial atom, 0.4 atomic volumes. The expansion of the crystal in the environment of the interstitial atoms was found to be slightly less than one atomic volume. Contrary to previous views, the region of the crystal containing the interstitial atom appeared to be more densely packed than the ideal crystal. The relative change in the elastic constants due to the relaxation process of an atomic concentration c of interstitial atoms in copper was calculated to be of the order 20 c. As far as they could be checked, these results are in fair agreement with the experimental data. By introducing additional data, for the electrical resistivity in copper, 2.5 μΩ cm/% Frenkel pairs and 0.9 μΩ cm/% interstitials were found. (auth)

6572 (AI-Trans-13) THE FORMATION OF GROWTH TWINS. R. Kern. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Bull. Soc. Franc. Mineral Crust., 84: 292-311(1961). 42p.

The law of twin crystals as expounded by G. Friedel is briefly recalled. A hypothesis on the formation of growth twins is made use of from the geometrical and energetic point of view. It is thought that the formation of growth twins is due to the conditions arising from surpassing the equilibrium; a report on the frequency of twins is given, and the effect of impurities on the growth of twins is analyzed. (auth)

6573 (AI-Trans-15) SPECIFIC HEAT AND TRANSITION HEATS OF THE VARIOUS MODIFICATIONS OF RUBIDIUM NITRATE AS WELL AS THEIR HEAT OF FUSION. Arvo Mustajoki. Translated by Anthony Cornell

(Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 9, 3-16(1958). 16p.

The values of the specific heat of the various modifications of rubidium nitrate were determined by means of the Moser calorimeter. Measurements were carried out on heating as well as on cooling. Interpolation formulas for the calculation of the specific heat of the different modifications are given. The points of transition, heats of transition, and transition entropies at the transitions between the different modification of $RbNO_3$ were determined. Starting with the lowest transition point, the following values were obtained for these: 160°C, 0.932 ± 1.5% kcal/mole and 2.15 ± 1.5% cal/g deg; 218°C on heating or 211°C on cooling, 0.767 ± 2% kcal/mole and 1.53 ± 2% cal/g deg; 281°C, 0.23 ± 6.5% kcal/mole and 0.42 ± 6.5% cal/g deg. Likewise melting point, heat of fusion, and fusion entropy were determined, for which the following values were obtained: 310°C, 1.109 ± 1.5% kcal/mole and 1.90 ± 1.5% cal/g deg. (auth)

6574 (AI-Trans-17) CALORIMETRIC INVESTIGATIONS CONCERNING THE TRANSITION IN $NaNO_3$ AND ITS MELTING PROCESS. Arvo Mustajoki. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.) from Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 5, (1957). 17p.

The values of the specific heat of $NaNO_3$ were measured upon heating as well as on cooling in the temperature range 60 to 345°C by the Moser calorimeter. On the basis of the anomalies of the curve of the specific heat, the heat of transition and the transition entropy of the λ transition taking place in the $NaNO_3$ crystal, as well as the heat of fusion and fusion entropy, were determined. The transition heat and the heat of fusion were also determined by means of direct enthalpy measurements. As transition heat and transition entropy, 944.0 cal/mole, and 1.26 cal/mole degrees were obtained. As heat of fusion and fusion entropy, 3.49 kcal/mole, and 6.03 cal/mole degrees were obtained. The values of molar heat as well as the enthalpy and entropy changes, from room temperature up, were calculated. (auth)

6575 (AI-Trans-20) ONE-DIMENSIONAL DISORDER IN CRYSTALS AND ITS EFFECT ON X-RAY INTERFERENCES. III. COMPARISON OF CALCULATIONS WITH EXPERIMENTAL RESULTS. Heinz Jagodzinski. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Acta Cryst., 2: 298-304(1949). 17p.

The limitations of the calculations carried out in the preceding papers on x-ray intensities of one-dimensional disordered crystals are discussed. Defect probabilities are also discussed. The experimental results of different authors on one-dimensional disorder are described, and a comparison is given of the calculated and experimental results for wurtzite, graphite, and SiC. (D.L.C.)

6576 (SC-T-525) A MILLISECOND MATRIX TIME METER. G. I. Mishin. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Pribory i Tekhn. Eksperim., No. 5, 106-12(1962). 12p.

A time meter permitting registration of 14 consecutive time intervals, at least 64 μsec long and not exceeding 16,448 μsec, is described. The margin of error in the measurements is only ±0.02 μsec and does not depend on the length of the time intervals. The maximum duration of the period of time measured by this instrument amounts to 230,273 μsec. (auth)

6577 (SC-T-527) FURNACES AND TEMPERATURE REGULATORS FOR PHYSICAL-CHEMICAL STUDIES UP TO 1700°C. Georges Urbain and Gilbert Cavalier. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Silicates Ind., 22: 527-32(1957). 14p.

The necessity of achieving temperatures of the order of 1700°C, perfectly constant in time, has led to a study of two types of laboratory furnaces, as well as their control arrangement. In the first setup, the heating element consists of a carbon tube and of a constant-power regulator associated with it, and not being subject to the effects of inertia can be adapted to different furnaces without advance regulation of the control power. The second setup comprises a furnace with molybdenum coils and a maintenance regulator which makes it possible to reduce the amplitude of temperature flucuations to the low value of plus or minus 1.5°C. A combination of these two types of regulators with any kind of furnace permits one to develop interesting performances, even with a power network displaying strong variations of potential. (auth)

6578 (SC-T-528) A STUDY OF THE SERIES $s_\alpha = \sum_{n=1}^{\alpha} n^\alpha p^{n-1}$ (α POSITIVE INTEGER) ENCOUNTERED IN THE STUDY OF THE GROWTH OF POLYMERS. Jacques Ravatin and Guy Mesnard. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Compt. Rend., 255: 2098-9(Oct. 1962). 4p.

The series $s_\alpha = \sum_{n=1}^{\alpha} n^\alpha p^{n-1}$, where p = fraction of monomer reacted in time t, is introduced into the kinetics of polymerizations. s_α is calculated for the first values of α (1, 2, 3, and 4), and more general relations are derived for s_α. New coefficients V_α^m are derived and their values are tabulated for the rapid calculation of s_α values. The properties of V_α^m are described. (D.L.C.)

6579 (SC-T-529) ANALYSIS OF TEMPERATURE DISPERSION CURVES OF DYNAMIC MODULUS IN CROSS-LINKED POLYMERS. Kyoichi Shibayama. Translated by Shyoko Hiraga (Sandia Corp., Albuquerque, N. Mex.), from Kobunshi Kagaku, 19: 543-6(1962). 9p.

Through application of Tobolsky's empirical equation for the time characteristics of relaxation modulus to the real part of dynamic modulus, a corresponding equation for mechanical loss, tan δ, was deduced. These equations were then transcribed into the form of temperature characteristics. A method of evaluation was proposed that included separating the temperature and the frequency dependence of the viscoelasticity, from the temperature dispersion curve obtained at a single frequency. (auth)

6580 (SC-T-530) SELF-OSCILLATION IN CIRCUITS WITH THERMISTORS. A. G. Shashkov. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 5: No. 11, 64-73(Nov. 1962). 15p.

A theoretical and experimental investigation was conducted on self-oscillations that are either very close to the sinusoidal ones or which differ sharply from them. Equations governing self-oscillations are obtained in their general form and in linear approximation. Conditions for self-excitation are formulated. Energy relations in the case of small oscillations are found, and the process of relaxation self-oscillations is considered. (auth)

6581 ELECTRON-TRANSFER REACTIONS OF AROMATIC THIOLATE ANIONS WITH ORGANIC OXIDIZING AGENTS. Frank J. Smentowski (Ames Lab., Ames, Iowa). J. Am. Chem. Soc., 85: 3036-7(1963). (IS-694)

A number of aromatic thiolate anions was found to undergo oxidation by nitrosobenzene in dimethyl sulfoxide–t-butyl alcohol solvent. A reasonably stable radical anion was detected as an intermediate and tentatively identified as nitrosobenzene radical anion. The following aromatic thiols undergo oxidation to the disulfide by nitrosobenzene: 2-naphthalenethiol, benzenethiol, p-t-butylbenzenethiol, thiosalicylic acid, p-chlorobenzenethiol, and p-nitrobenzenethiol. Other oxidants were also studied, and are arranged in the following order according to their ability to dimerize potassium 2-naphthalenethiolate: azodicarbonamide > nitrosobenzene > maleic anhydride ≫ acrylonitrile > nitrobenzene > acrylamide. (D.L.C.)

6582 CONTROLLED-POTENTIAL AND DERIVATIVE POLAROGRAPH Q-1988A (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1001)

This package contains 5 drawings and 16 specifications. The polarograph, Q-1988-A, is a refinement of Q-1988. They are both controlled-potential d-c polarographs. It is used for high-sensitivity polarography both regular and derivative. In the modified polarograph, the polarizing unit has electronic scan and linear residual current compensation. The output of the electronic scan circuit is stable enough for derivative polarography at high sensitivity and has less noise than does the output of the electromechanical system used in Q-1988. The performance of the electronic scan circuit is superior to that of a conventional motor-driven multiturn potentiometer scanner. Derivative polarograms can be measured down to micromolar concentrations. With a stable drawn out capillary, the detection limit can be extended to at least 10^{-7} molar. (F.S.)

6583 FRAME CAMERA, MODEL 11–2,640,000 FPS, F/4.0 (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1035)

This package contains 3 drawings. The rotating-mirror camera with 56 frames, 5 mm square, has superior resolution of lenses that were designed by means of the Holladay lens code. The blur resulting from image sweep caused by rotation and high speed (11,000 rps) of the rotating mirror is corrected. Two special lenses include a 1,100-mm-front-focus objective lens for operation at unit magnification at f/14 and a 250-mm-front-focus relay lens for quarter magnification at f/3.5. The camera also has a simple, focusing, easily removed, relay-lens mount; a viewfinder and focusing microscope for observing the image at the film position; magazines for 35-mm perforated film in 100-ft rolls or miniature-camera loads; a Brixner blast shutter; a transistorized photoelectric synchronizer; and a semiportable mount for the camera assembly. (F.S.)

6584 FLUORINE PLANT AND EQUIPMENT (Engineering Materials). (Union Carbide Nuclear Co. Paducah Plant, Ky.). (CAPE-55)

This package contains 34 drawings. Fluorine is produced by the electrolysis of hydrogen fluoride in a fused salt electrolyte (KF·2HF). The plant is capable of multi-ton daily output rates from 4,000 and 5,000 amp cells. The cells are medium temperature, water-cooled, and series-connected electrically. The cells are composed of a carbon anode assembly and a steel cathode assembly. Fluorine is generated at the carbon electrodes and collected in a gas chamber around the anode assembly. Hydrogen is evolved at the cathode surface and is collected in a gas chamber formed by the cell cover and inner shell walls. Both cases are piped to surge tanks and then purified by passing through Monel condensers to remove most of the entrained hydrogen fluoride. The average on-stream efficiency of the fluorine cells is about 95%. (F.S.)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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423909	18-5977	See RTD-TDR-63-4071(Pt.I)
AEC-tr-		
6144	18-6528	Dep.(mc); $1.60(fs), $0.80(mf) JCL
6145	18-5354	Dep.(mc); $1.60(fs), $0.80(mf) JCL
6146	18-5257	Dep.(mc); $1.10(fs), $0.80(mf) JCL
6189	18-4947	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
AECL-	(Canadian)	
1865	18-6191	Can. J. Phys., 41: 2202-5(1963)
1868	18-5211	See CRRD-1171
AED-C-	(German)	
15-02	18-5974	Dep.(mc)
22-01	18-6511	Dep.(mc)
AEDC-TDR-	(Non-AEC)	
63-187	18-5572	$4.60(OTS)
AEEW-R-	(British)	
134	18-5459	Dep.(mc)
187	18-6456	p.445-502 of "Heavy Water Lattices: Second Panel Report." Vienna, IAEA, 1963
214	18-5460	Dep.(mc)
222	18-5461	Dep.(mc)
250	18-6415	p.417-43 of "Heavy Water Lattices: Second Panel Report." Vienna, IAEA, 1963
267	18-5462	Dep.(mc)
AERE-R-	(British)	
4069	18-5747	Radiochim. Acta, 2: 14-19(1963)
4392	18-5478	Dep.; $0.90(BIS); 4s. 6d. (HMSO)
AFCRL-	(Non-AEC)	
63-52	18-6081	See ARF-A204-3
AFOSR-	(Misc.)	
2249	18-5898	Ann. Astrophys., 26: 234-49(1963)
AHSB(S)-	(British)	
R-62	18-6153	Dep.; $0.60(BIS); 2s. 9d. (HMSO)
AI-TRANS		
11	18-6567	Dep.(mc); $1.10(fs), $0.80(mf) JCL
12	18-6571	Dep.(mc); $3.60(fs), $1.37(mf) JCL
13	18-6572	Dep.(mc); $4.60(fs), $1.46(mf) JCL
15	18-6573	Dep.(mc); $1.60(fs), $0.80(mf) JCL
16	18-5258	Dep.(mc); $1.60(fs), $0.80(mf) JCL
17	18-6574	Dep.(mc); $1.60(fs), $0.80(mf) JCL
18	18-6103	Dep.(mc); $1.10(fs), $0.80(mf) JCL
20	18-6575	Dep.(mc); $1.60(fs), $0.80(mf) JCL
ANL-		
6550	18-5749	Dep.; $0.75(OTS)
6651	18-5811	Dep.; $0.50(OTS)
6665	18-5812	Dep.; $1.00(OTS)
6678	18-5813	Dep.; $0.50(OTS)
6706	18-6411	Dep.; $2.75(OTS)
6756	18-6154	Dep.; $2.60(fs), $0.86(mf) OTS
6787	18-6136	Dep.; $2.75(OTS)
APDA-	(Misc.)	
156	18-6483	Dep.(mc); $6.60(fs), $2.06(mf) OTS
ARF-	(Misc.)	
A204-3	18-6081	$2.60(OTS)
ARL-	(Non-AEC)	
63-216	18-6020	Phys. Math. Univ. Oslo Inst. Rept., No. 19, 31p. (1963)
AROD-	(Misc.)	
2800.12	18-5841	
ASD-TDR-	(Non-AEC)	
62-323	18-5770	
62-509(Vol.I)	18-5777	See NMI-9516(Vol.I)
62-509(Vol.II)	18-5778	See NMI-9516(Vol.II)
62-720	18-5842	$2.50(OTS)
63-270(Pt.II)	18-5728	OTS
63-744	18-5729	OTS
63-858	18-6299	
AWRE-O-	(British)	
49/63	18-5771	Dep.(mc)
82/63	18-6155	Dep.(mc)
BAW-	(Misc.)	
170	18-6512	
BLG-	(Belgian)	
196	18-5912	Dep.(mc)
BMI-X-		
266	18-5772	Dep.(mc); $1.60(fs), $0.80(mf) OTS
BNL-		
827	18-5730	Dep.; $0.50(OTS)
6943	18-5082	Radiation Botany, 3: 239-47(1963)
6968	18-5081	Radiation Botany, 3: 231-7(1963)
6994	18-6209	Nucl. Phys., 48: 385-407(1963)
7076	18-5397	Phys. Chem. Solids, 24: 1341-7(1963)
7188	18-6238	Phys. Rev., 133: B42-62(1964)
7231	18-6237	Phys. Rev., 133: B35-41(1964)
7237	18-6242	Phys. Rev., 133: B113-16(1964)
7248	18-5670	Rev. Sci. Instr., 34: 1398-9(1963)
7254	18-5383	J. Phys. Chem., 67: 2827-30(1963)
7309	18-5835	Phys. Rev., 133: A595-606(1964)
7478	18-5607	Dep.(mc); $1.10(fs), $0.80(mf) OTS

Report No.	Abstract No.	Availability
CAPE–		
52	18-5429	EM
55	18-6584	EM
558	13-5679	EM
1001	18-6582	EM
1035	18-6583	EM
1037	18-5678	EM
1038	18-5453	EM
1042	18-5595	EM
1047	18-6426	EM
1052	18-5430	EM
1055	18-5569	EM
1061	18-5895	EM
1063	18-5596	EM
1064	18-5896	EM
1068	18-5570	EM
CEA–	**(French)**	
2283	18-5463	Dep.(mc)
CEND–	**(Misc.)**	
157	18-5750	Dep.; $2.75(OTS)
CERN–	**(European Organization for Nuclear Research)**	
63-33	18-5886	Dep.(mc)
63-34	18-5718	Dep.(mc)
63-36	18-5447	Dep.(mc)
CLM–	**(British)**	
P26	18-6354	Proc. Phys. Soc. (London), 82: 938-46 (1963)
CONF-38–	**(American Physical Society Division of Plasma Physics Meeting, Atlantic City, November–December 1962)**	
10	18-6298	See 63-RL-3226E
CONF-39–	**(American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963)**	
106	18-6151	ORINS. Gmelin, AED-CONF-63-060-111
CONF-117–	**(American Chemical Society 145th National Meeting, New York, September 1963)**	
31	18-5361	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-133-12
CONF-157–	**(American Chemical Society Northwest Regional Meeting, Bellingham, Wash., June 1963)**	
5	18-5210	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-096-6
CONF-229–	**(Eastern Analytical Symposium, New York, November 1962)**	
2	18-5573	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CONF-243–	**(American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Canada, October 1963)**	
34	18-6417	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-35
35	18-5742	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-33
36	18-6518	Dep.(mc); $4.60(fs), $1.64(mf) OTS; Gmelin, AED-CONF-63-168-31
37	18-6484	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-30
CONF-251–	**(Rotating Machinery for Gas Cooled Reactor Application, Gatlinburg, Tenn., November 1963)**	
4	18-6489	See LADC-6093
CONF-311–	**(American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, New Mex., October 1963)**	
8	18-6513	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-163-7
CONF-331–	**(The Metallurgical Society of American Institute of Mechanical Engineers Annual Meeting, Dallas, February 1963)**	
2	18-5814	Dep.(mc); $4.60(fs), $1.49(mf) OTS; Gmelin, AED-CONF-63-029-4
CONF-332–	**(Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., November 1963)**	
1	18-5845	See LADC-5876
CONF-339–	**(The Metallurgical Society of A.I.M.E. Fall Meeting, Cleveland, October 1963)**	
2	18-5773	Dep.(mc); $2.60(fs), $0.95(mf) OTS; Gmelin, AED-CONF-63-176-2
CONF-342–	**(Conference on Magnetism and Materials, Atlantic City, November 1963)**	
1	18-5846	See LADC-5915
CONF-343–	**(Pacific Northwest Section Meeting of American Society of Agricultural Engineers, Portland, Ore., October 1963)**	
1	18-4999	See HW-SA-3226
CONF-344–	**(Meeting of the Institute of Electrical and Electronic Engineers, San Diego, Calif., 1963)**	
1	18-5574	See LADC-5896
CONF-346–	**(International Conference on Nuclear Physics with Reactor Neutrons, Argonne, Ill., October 1963)**	
2	18-6159	See LADC-5990
CONF-347–	**(Proceedings of Uppsala Angular Correlation Conference, Uppsala, Sweden, May 1963)**	
1	18-6182	See UCRL-11024
CONF-349–	**(15th Annual Phytopharmacy Symposium, Ghent, Belgium, May 1963)**	
1	18-6549	Dep.(mc); $4.60(fs), $1.46(mf) OTS
CONF-354–	**(Accelerator Conference, Boston, Mass., November 1963)**	
1	18-6156	Dep.(mc); $3.60(fs), $1.22(mf) OTS
CONF-363–	**(International Symposium on Plasma Phenomena, San Diego, Calif., October 1963)**	
2	18-6300	See GA-4735
COO–		
275	18-5362	Dep.; $2.25(OTS)
CRRD–	**(Canadian)**	
1171	18-5211	Dep.; $0.20(AECL)
DLCS–		
3570108	18-6485	Dep.(mc); $1.10(fs), $0.80(mf) OTS
4140101	18-6486	Dep.(mc); $1.60(fs), $0.80(mf) OTS
DMIC–	**(Non-AEC)**	
189	18-5774	
DP–		
809	18-5412	Dep.; $0.75(OTS)
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		

Report No.	Abstract No.	Availability
EANDC(E)–	**(European-American Nuclear Data Committee)**	
46(L)	18-6446	Dep.(mc)
EANDC(OR)–	**(European-American Nuclear Data Committee)**	
21U	18-6181	See RISO-61
EFINS–	**(Misc.)**	
63-36	18-6110	Phys. Rev., 133: A1-14(1964)
EP–	**(Misc.)**	
3912-107-63U	18-6562	See TID-19804
ER–	**(Misc.)**	
6590	18-5816	See NP-13405
ETR–	**(Belgian)**	
139	18-5575	See NP-13288
EUR–	**(European Atomic Energy Community)**	
112.e,f(Vol.1)	18-5544	Dep.(mc); $3.60(fs), $1.25(mf) OTS
112.e,f(Vol.3)	18-5545	Dep.(mc); $26.00(fs), $15.41(mf) OTS
386.f	18-5225	Nem. Sci. Rev. Met., 60: No. 3, 189-94 (1963)
436.f	18-5413	Dep.(mc)
438.f	18-5212	Dep.(mc)
443.f	18-6358	Spectrochim. Acta, 19: 1323-34(1963)
450.f	18-5476	Ann. Soc. Geol. Belg., Bull., 86: B229-69 (1963)
452.e	18-5824	J. Appl. Phys., 34: 2200-9(1963)
468.i	18-6487	Dep.(mc)
490.e	18-6519	Dep.(mc)
EURAEC–		
374(Vol.1)	18-5544	See EUR-112.e,f(Vol.1)
374(Vol.3)	18-5545	See EUR-112.e,f(Vol.3)
597	18-5750	See CEND-157
GA–	**(Misc.)**	
4624	18-6470	Dep.(mc); $9.60(fs), $3.59(mf) OTS
4735	18-6300	
4742	18-5815	Dep.(mc); $1.10(fs), $0.80(mf) OTS
GAMD–	**(Misc.)**	
3470	18-6418	Dep.(mc); $14.50(fs), $6.65(mf) OTS
3470(App.I)	18-6419	Dep.(mc); $8.10(fs), $2.84(mf) OTS
GAT-T–		
1088/Rev.1	18-5272	Inorg. Chem., 2: 1012-5(1963)
GEAP–		
3888	18-6412	Dep.; $2.75(OTS)
3899	18-5464	Dep.; $2.75(OTS)
GEMP–		
80	18-6420	Dep.; $0.50(OTS)
GEST–	**(Misc.)**	
2011	18-5975	
GTR–		
20	18-6550	Dep.(mc); $5.60(fs), $1.85(mf) OTS
HMI-B–	**(German)**	
29	18-6520	Dep.(mc)
HNS–		
1229-38	18-6551	Dep.(mc); $3.60(fs), $1.25(mf) OTS
HPR–	**(Norwegian)**	
32	18-6488	Dep.(mc)

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HW–		
66354	18-5751	Dep.(mc); $2.60(fs), $0.83(mf) OTS
68600-33	18-5731	Dep.; $0.50(OTS)
72666	18-5414	Dep.; $2.75(OTS)
77344	18-6157	Dep.(mc); $1.10(fs), $0.80(mf) OTS
77356	18-6508	Dep.; $0.75(OTS)
78819	18-5743	Dep.(mc); $1.10(fs), $0.80(mf) OTS
79081	18-5775	Dep.(mc); $1.10(fs), $0.80(mf) OTS
79393	18-6536	Dep.(mc); $2.60(fs), $0.83(mf) OTS
HW-SA–		
3133	18-5078	Proc. Soc. Exptl. Biol. Med., 114: 554-9 (1963)
3226	18-4999	Dep.(mc); $1.10(fs), $0.80(mf) OTS
IA–	**(Non-AEC)**	
832	18-5707	Dep.(mc)
850	18-5381	J. Phys. Chem., 67: 2708-14(1963)
854	18-5985	Dep.(mc)
IDO–		
14599	18-5415	Dep.; $1.00(OTS)
14604	18-5416	Dep.; $1.00(OTS)
16906	18-6521	Dep.; $2.50(OTS)
16923	18-5628	Dep.; $0.75(OTS)
IEA–	**(Non-AEC)**	
63	18-5739	ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo), 19: 571-8(1963)
64	18-5738	ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo), 19: 539-55(1963)
65	18-6495	ABM (Bol. Assoc. Brasil. Metais) (Sao Paulo), 19: 557-69(1963)
IITRI–	**(Misc.)**	
1184-11	18-5843	Dep.(mc); $5.60(fs), $1.82(mf) OTS
B6005-11	18-5776	Dep.(mc); $4.60(fs), $1.70(mf) OTS
B6007-5	18-5732	$1.60(OTS)
IS–		
643	18-5790	J. Appl. Phys., 34: 2691-4(1963)
678	18-5252	Dep.; $1.50(OTS)
694	18-6581	J. Am. Chem. Soc., 85: 3036-7(1963)
734	18-6552	Dep.; $2.50(OTS)
JINR–	**(Russian)**	
P-1320	18-6158	Dep.(mc)
P-1392	18-5986	Dep.(mc)
P-1401	18-5987	Dep.(mc)
P-1402	18-5988	Dep.(mc)
P-1403	18-5989	Dep.(mc)
P-1407	18-5990	Dep.(mc)
P-1416	18-5629	Dep.(mc)
P-1430	18-5991	Dep.(mc)
P-1433	18-5630	Dep.(mc)
JPL-TR–	**(Non-AEC)**	
32-371	18-5897	
32-512	18-6460	
JPRS–	**(Non-AEC)**	
21975(Del.)	18-5549	$0.50(OTS)
21989	18-4958	$0.50(OTS)
22107	18-5010	$0.50(OTS)
22123	18-5139	$0.50(OTS)
22147	18-5140	$0.75(OTS)
22180(Excerpt)	18-5141	$1.25(OTS)
22295(Del.)	18-4970	$0.75(OTS)
22385	18-5708	$0.50(OTS)
22400	18-5011	$0.50(OTS)

Report No.	Abstract No.	Availability
JoL–	**(German)**	
56-ST	18-5488	Meteorol. Rundschau, 15: 45-7(1962)
82-RG	18-6423	Bauingenieur, 37: 357-61(1962)
128-RG	18-5441	Dep.(mc)
K–		
1542	18-5213	Dep.; $0.50(OTS)
KAPL–		
2259	18-6447	Dep.(mc); $4.60(fs), $1.55(mf) OTS
KFK–	**(German)**	
173	18-5118	p.359-74 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963
KR–	**(Norwegian)**	
53	18-5744	Dep.(mc)
55	18-5722	Dep.(mc)
LA–		
2987	18-5844	Dep.; $2.00(OTS)
LADC–		
5569	18-6509	Dep.(mc); $3.60(fs), $1.37(mf) OTS
5578	18-6213	Nucl. Phys., 48: 433-42(1963)
5585	18-5281	J. Phys. Chem., 67: 2655-9(1963)
5827	18-5923	Phys. Rev., 133: A52-68(1964)
5876	18-5845	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5896	18-5574	Dep.(mc); $2.60(fs), $0.92(mf) OTS
5915	18-5846	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5990	18-6159	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6093	18-6489	Dep.(mc); $1.10(fs), $0.80(mf) OTS
LAMS–		
2944	18-6301	Dep.; $2.00(OTS)
2962	18-5546	Dep.; $0.50(OTS)
2986	18-6553	Dep.; $0.50(OTS)
3004	18-6302	Dep.; $2.50(OTS)
MATT–		
177	18-6351	Phys. Rev., 133: A436-42(1964)
MND–	**(Misc.)**	
2903(Vol.II)	18-6490	Dep.; $2.25(OTS)
N–	**(Misc.)**	
63-22882	18-5737	See PWA-2255
NAA-SR–		
7534	18-5465	Dep.; $0.75(OTS)
7880	18-6491	Dep.; $0.50(OTS)
8387	18-5733	Dep.; $0.75(OTS)
NAA-SR-Memo–		
8824	18-6514	Dep.(mc); $3.60(fs), $1.13(mf) OTS
9101	18-6515	Dep.(mc); $6.60(fs), $2.21(mf) OTS
NADC-EL–	**(Non-AEC)**	
N6301	18-5696	$2.60(OTS)
NASA-SP–	**(Non-AEC)**	
31	18-5807	Measurement of Thermal Radiation Properties of Solids. Washington, D. C., National Aeronautics and Space Administration, 1963. $3.50(GPO)
NMI–	**(Misc.)**	
2121	18-5734	Dep.(mc); $2.60(fs), $1.10(mf) OTS
2122	18-5735	Dep.(mc); $4.60(fs), $1.49(mf) OTS
9516(Vol.I)	18-5777	$3.50(OTS)
9516(Vol.II)	18-5778	$3.50(OTS)

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NP–	**(AEC File No.**	**for Non-AEC Reports)**
13281	18-4939	$10.10(OTS)
13288	18-5575	
13326	18-6160	Dep.(mc)
13328	18-6303	Dep.(mc)
13331	18-5887	Dep.(mc)
13334	18-6304	Dep.(mc)
13335	18-6305	Dep.(mc)
13336	18-6306	Dep.(mc)
13337	18-5253	Dep.(mc)
13339	18-6421	Dep.(mc)
13344	18-5914	Dep.(mc)
13346	18-6161	Dep.(mc)
13347	18-5992	Dep.(mc)
13348	18-6162	Dep.(mc)
13349	18-6163	Dep.(mc)
13354	18-6164	Dep.(mc)
13355	18-5993	Dep.(mc)
13358	18-6307	Dep.(mc)
13359	18-6165	Dep.(mc)
13362	18-6308	Dep.(mc)
13367	18-6166	Dep.(mc)
13381	18-6167	Dep.(mc)
13382	18-5631	
13387	18-6554	Dep.(mc)
13389	18-6168	Dep.(mc)
13390	18-6555	Dep.(mc)
13401	18-5847	
13402	18-6309	
13403	18-5779	
13405	18-5816	
13425	18-5736	
13426	18-6169	
13429	18-5780	
13438	18-6522	Dep.(mc)
13439	18-6170	Dep.(mc)
13442	18-6461	Dep.(mc)
13443	18-6448	Dep.(mc)
13444	18-6171	Dep.(mc)
13445	18-6471	Dep.(mc)
13446	18-6472	Dep.(mc)
13447	18-6137	Dep.(mc)
NPCC-FEWP–	**(British)**	
(63)/P-122	18-5783	See TRG-Report-564
NRC–	**(Canadian)**	
7579	18-6315	Can. J. Phys., 41: 1960-6(1963)
7580	18-6314	Can. J. Phys., 41: 1949-59(1963)
NYO–		
10398	18-6492	Dep.; $3.50(OTS)
10690	18-6556	Dep.(mc); $3.60(fs), $1.40(mf) OTS
10716	18-5994	Dep.(mc); $7.60(fs), $2.45(mf) OTS
ORA–	**(Misc.)**	
02921-4F	18-5481	See TID-19820
ORNL–		
3499(Vol.I)	18-6138	Dep.; $3.00(OTS)
ORNL-TM–		
603	18-6537	Dep.(mc); $10.10(fs), $3.83(mf) OTS
687	18-5417	Dep.(mc); $2.60(fs), $1.01(mf) OTS
712	18-4940	Dep.(mc); $1.10(fs), $0.80(mf) OTS
737	18-5725	Dep.(mc); $1.60(fs), $0.80(mf) OTS
OTS–	**(Misc.)**	
62-11757	18-5208	$1.75(OTS)
63-41204	18-4958	For translation see JPRS-21989
63-41271	18-5010	For translation see JPRS-22107

Report No.	Abstract No.	Availability
63-41281	18-5139	For translation see JPRS-22123
63-41298	18-5140	For translation see JPRS-22147
63-41311(Excerpt)	18-5141	For translation see JPRS-22180(Excerpt)
64-21025(Del.)	18-4970	For translation see JPRS-22295(Del.)
64-21075	18-5708	For translation see JPRS-22385
64-21087	18-5011	For translation see JPRS-22400
PAN–	(Polish)	
257	18-6180	Dep.
270	18-5636	Dep.
402/VI	18-6408	Dep.
438/II	18-5817	Dep.
444/Ia,II,IX	18-5637	Dep.
454/VI	18-5944	Dep.
460/VI	18-5945	Dep.
PAS–	(French)	
62/17	18-6528	For translation see AEC-tr-6144
PATENTS	(British)	3s. 6d. each, U. K. Patent Office
937,573	18-5759	
937,588	18-5454	
937,660	18-6476	
937,663	18-5248	
937,673	18-6477	
937,682	18-5403	
937,764	18-5695	
937,844	18-6397	
937,991	18-5760	
938,120	18-6464	
938,122	18-5470	
938,127	18-5715	
938,159	18-6535	
938,167	18-6427	
938,179	18-6428	
938,190	18-6429	
938,211	18-6546	
938,233	18-5597	
938,252	18-6430	
938,257	18-6431	
938,296	18-6478	
938,311	18-6547	
938,352	18-5471	
938,355	18-5404	
938,395	18-6432	
938,405	18-5761	
938,441	18-5598	
938,446	18-6504	
938,488	18-5537	
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PG-Report–	**(British)**	
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63	18-5479	Dep.(mc)
64	18-5480	Dep.(mc)
68	18-5638	Dep.(mc)
RM–	**(Misc.)**	
3671-PR	18-6082	
RRL–		
108	18-5401	Z. Physik. Chem. (Frankfurt), 38: 285-94 (1963)
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63-4071(Pt.I)	18-5977	$13.50(OTS)
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448(Rev.)	18-5547	$0.10(OTS)
455(Rev.)	18-4941	$0.10(OTS)
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521	18-4943	$0.10(OTS)
63-15	18-5571	See AD-423673
63-44	18-5748	See AD-423723
63-46	18-5973	See AD-423714
63-50	18-5440	See AD-423823
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7730(Pt.II)	18-6348	Phys. Rev., 133: A132-4(1964)
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